Model based intervention for sentence production disorders in patients with aphasia.

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Abstract

The thesis used a cognitive neuropsychological approach to analyse the effects of a model-based intervention on the production of sentences in people with aphasia. The thesis consisted of two studies, Study 1 and Study 1A.

Study 1 examined the effect of three intervention modules designed on the basis of GEM, on production of sentences in people with aphasia. Specifically, Study 1 analysed the responses of the participants to the experimental intervention by evaluating the change in the production of trained stimuli, untrained stimuli and spontaneous speech. Study 1 examined the relationship between verb retrieval and sentence production. Stimuli included verbs and nouns at three linguistic levels: word level, affix level and sentence level. Two of the six participants showed a significant improvement in the production of trained items, one in the production of verbs and the other in the production of nouns at the three levels of intervention. A consistent relationship between verb retrieval and sentence production was not found. Generalisation to spontaneous speech in terms of an improvement in the number of nouns and verbs produced was seen in two of the six participants.

Study 1A examined the effect on production of sentences of a verb argument module that involved presentation of a verb and its arguments. Three of the four participants showed a significant improvement in the production of sentences after the verb argument module. The performance patterns of the participants implied that verbs plus their arguments were important but not sufficient for sentence production.

The studies in this thesis suggest that, in order to be able to predict the generalisation pattern in people with aphasia, GEM requires a more detailed specification of the processes required for sentence production to be able to predict the generalisation patterns in people with aphasia. In addition, it is important to match the baseline abilities of an individual to the features of the intervention task for an intervention to be successful.

1 Chapter One: Overview

Aphasia is a language disorder caused as a result of brain damage. People with aphasia may experience a combination of symptoms such as an inability to understand, to read, to write, to produce a single word or to form a sentence. They may present with different combinations of symptoms and the degree of severity of a particular symptom may vary. In people with aphasia, one or more of these symptoms result in an inability to communicate effectively and have a devastating effect on a patient's life.

A number of approaches exist in the literature to study aspects of language behavior in patients with aphasia. As a result of interdisciplinary influences from areas such as linguistics, neurology and psychology, new disciplines have evolved (e.g., psycholinguistics) that integrate the information about the nature of language from linguistics, the nature of brain damage from neurology and the information about experimental methods from psychology resulting in contemporary approaches such as psycholinguistics and cognitive neuropsychology. A cognitive neuropsychological approach within aphasiology uses theories of normal language processing to examine the cognitive abilities of brain-damaged patients and/or to guide intervention (Coltheart, 2001).

1.1 The problem

In intervention studies, models do not define the therapy task (Basso & Marongolo, 2000). Tailoring the intervention to the locus of impairment may or may not result in similar results in patients with the same level of impairment (e.g., Hillis and Caramazza, 1994). Models are not detailed enough to explain how a cognitive function is modified in response to an intervention task (Hillis, 2001). Despite this fact, models are regularly used as a basis for experimental interventions in research studies (e.g., Hillis, 1991; Mitchum & Berndt, 1994). Responses of patients with brain damage are analysed to inform or learn more about the model.

In the area of sentence processing, model-based treatment studies have focused on the relationship between lexical retrieval and sentence production. Experiments that examine the relationship between verb retrieval and sentence production have found contradictory results. For example, Mitchum & Berndt (1994) did not find any generalisation from verb retrieval to sentence production while Marshall et al. (1998) found generalisation to sentence production. In terms of the effect of intervention on language processing, researchers have tried to explain the relationship between the skills of patients and the components of the intervention task (e.g., Best & Nickels, 2000). In terms of generalisation in sentence production interventions, researchers have not found consistent generalisation from trained to untrained items (e.g., Raymer & Ellsworth, 2002; Schneider & Thompson, 2003).

The use of a model of sentence production in this thesis forms the basis for hypothesis testing. In addition, the information needed to produce sentences according to the model helps to structure the experimental intervention.

1.2 Present thesis

The current study uses a cognitive neuropsychological approach to test the validity of a model of sentence production in normal speakers by using language-impaired individuals as participants. This thesis consists of two studies: Study 1 and Study 1A which is an extension of Study 1.

The four main areas of emphasis in the present thesis are:

Model-based intervention for disorders in sentence production: The studies use a consolidated model of sentence production based on Garrett (1984), Bock & Levelt (1994) and Levelt, Roelofs and Meyer (1999) to design an experimental intervention in three different modules to test the validity of the consolidated model. The consolidated model of sentence production used in this thesis is referred to as the grammatical encoding model (GEM). The importance of using GEM is assessed by evaluating the responses of the participants to a model-based experimental intervention. First, the consolidated model is used to predict hypothetical performance patterns of participants with breakdowns at different levels of the model. Secondly, six participants with chronic aphasia are given an intervention based on GEM. The same three intervention modules are given to each participant and their responses are recorded. Thirdly, the responses are analyzed to find each participant's probable locus of impairment and compared with the hypothetical performance patterns predicted by the GEM.

The studies in this thesis provide the same intervention to a heterogeneous set of patients. This heterogeneity is required to answer the question: What are the factors that are crucial for a patient to respond positively to an intervention?

Similar experiments using a model-based intervention with an emphasis on sentence production are few (e.g., Mitchum & Berndt, 1994; Marshall et al., 1998) and the results vary. The treatment in the existing studies in the clinical aphasiology literature is restricted to one level of the model only or involves more than one level simultaneously resulting in an inability to differentiate the role a particular level of the model plays in the treatment.

Evaluation of the relationship between lexical retrieval and sentence production: This area is important in clinical aphasiology because of its implications for therapy. The relationship between lexical retrieval and sentence production is examined in this thesis in three ways: a) by evaluating generalisation from training verbs in isolation to production of sentences (Study 1); b) by evaluating generalisation from training nouns in isolation to production of sentences (Study 1); and c) by comparing the number of verbs produced and the number of sentences produced during intervention (Study 1A). The importance of both noun and verb retrieval for sentence production is evaluated.

As will be discussed in Chapter 4, lexical factors such as frequency of occurrence, elicitation context, semantic factors, argument structure and instrumentality may affect the production of verbs at the single word level and factors such as argument structure and overall verb retrieval may affect sentence production. In this thesis, verbs were categorised in terms of their argument structure and as many other factors as possible were controlled.

Prediction of generalisation patterns in patients with aphasia: One of the aims of an aphasiologist while providing therapy is to achieve generalisation from trained items to untrained items. Generalisation from trained to untrained items has been seen in some studies (e.g., Schneider and Thompson, 2003) but not in others (e.g., Raymer and Ellsworth, 2002). The studies in this thesis examine whether linguistic similarity enhances the chances of generalisation from trained to untrained items.

Generalisation from intervention to spontaneous speech: An aphasiologist providing therapy also aims to achieve generalisation to spontaneous speech in the everyday life of the patient. A lack of generalisation from intervention to spontaneous speech is evident in the aphasiology literature. Experiments focusing on sentence production raise an interesting question as to the reason behind the lack of generalisation to spontaneous speech seen in these patients. Researchers answer this question by assigning additional factors besides verb retrieval to sentence production (e.g., Mitchum & Berndt, 1994).

The studies in this thesis explore generalisation from intervention to spontaneous speech by obtaining a speech sample at the baseline and after each module of intervention. These samples are analysed using the Language Assessment Remediation and Screening Procedure (LARSP; Crystal, Fletcher & Garman, 1976). Five different variables are assessed: total utterances produced, clausal complexity, number of nouns, number of verbs and the syntactic complexity score.

1.3 Thesis outline

The thesis describes approaches to sentence production in aphasiology and in linguistics in Chapter 2. Chapter 3 provides a description of the processes postulated by models of sentence production focusing on Garrett's model and Bock & Levelt's model of sentence production. Chapter 3 presents the consolidated grammatical encoding model (GEM) that forms the basis for the experimental intervention. Chapter 4 discusses lexical retrieval, sentence production and the relationship between lexical retrieval and sentence production. The emphasis in Chapter 4 is on the application of model-based interventions to sentence production disorders. Chapter 5 discusses the aims and the hypotheses of the current study followed by the methodology for Study 1. The results of Study 1 are presented in Chapter 6 and discussed in Chapter 7. Chapter 8 presents the methodology, results and discussion of Study 1A.

Chapter 9 concludes the thesis by discussing the significance of applying a model-based intervention to sentence production disorders in patients with aphasia. The implications of the results of the two studies for GEM are discussed, followed by limitations of the study and suggestions for future research. A glossary of terms is included at the end of the thesis.

2 Chapter Two: Approaches to sentence production: Aphasiology and Linguistics

The focus of the present study is on sentence production in individuals with aphasia. The current study uses information from linguistics to design a model-based experimental intervention in order to test the validity of the model used. Linguistics is concerned with the study of particular languages in order to be able to produce complete and accurate descriptions of them and to be able to obtain information about the nature of language in general (Crystal, 1968, p. 27). Clinical aphasiology deals with clinical issues relevant to diagnosis, evaluation and treatment of brain-injured persons with linguistic impairment (Brookshire, 1983).

In brain-injured persons, a linguistic impairment affects the relationship between speech and words. The relationship between speech and words is best described by quoting Hughlings Jackson's (1864) words:

> It is not enough to say that speech consists of words. It consists of words referring to one another in a particular manner; and without a proper interrelation of its parts, a verbal utterance would be a mere succession of names embodying no proposition. Loss of speech is the loss of power to propositionize...Speechlessness does not mean entire wordlessness (Jackson, 1864[1]).

The field of linguistics has contributed to aphasiology in terms of different methods to assess, describe, diagnose and treat various symptoms of aphasia. In the current study, the contribution of linguistics includes information related to verbs and to models of sentence production (e.g., Garrett, 1984, Bock & Levelt, 1994).

2.1 Types of aphasia

Individuals with aphasia vary in the symptoms they exhibit. This variation in symptoms has resulted in a need for classifying the different types of symptoms into different types of aphasia syndromes. This section will describe the types of aphasia relevant to the present study followed by issues related to the classification of individuals with aphasia into these types.

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[1] Cited in Jakobson and Halle (1956, p. 85).

A syndrome is a recurring pattern of symptoms. According to the syndrome typology by Geschwind, Goodglass and their associates in the Boston school of aphasiology (Benson & Geschwind, 1971, also known as the neo-classical approach), there are two broad categories: nonfluent and fluent aphasias. The nonfluent category includes Broca's aphasia, transcortical motor aphasia, aphemia, global aphasia and isolation of speech area. Fluent aphasias include Wernicke's aphasia, anomic aphasia, conduction aphasia and transcortical sensory aphasia. Here only Broca's aphasia, Global aphasia and Wernicke's aphasia will be described as they are the categories relevant to the current study.

Broca's aphasia is characterised by nonfluent conversational speech and good comprehension. This type of aphasia is usually associated with lesions of cortical and subcortical tissue of the lower posterior frontal lobe, including the precentral gyrus. Area 44 is located in the third frontal convolution anterior to the pre-central gyrus, known as Broca's area. Naming and repetition may be affected. Reading and writing abilities are commensurate with speech production and repetition but sometimes involve severe difficulty with small grammatical words (Goodglass, 1981, p. 9).

Global aphasia is characterised by nonexistent conversational speech and poor auditory comprehension. This is usually associated with a large perisylvian lesion involving the frontal, temporal and parietal language zones. Ability to say or to nod "yes" and "no" may or may not be retained. Naming and repetition are impossible. There is no functional reading, and writing is limited to copying text or writing his or her name (Goodglass, 1981, p. 11).

Wernicke's aphasia is characterised by fluent conversation and impaired auditory comprehension. This aphasia is the most severely impaired fluent syndrome, caused by a lesion in the posterior superior region of the temporal lobe. Naming and repetition are impaired. Naming is marked by both literal[2] and semantic[3] paraphasias and neologisms[4]. Reading and writing are impaired remarkably (Goodglass, 1981).

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[2] The nonword produced by the patient is related in sound to the target word in literal paraphasia e.g. *lat/cat*.

[3] The word produced by the patient is related in meaning (not sound) to the target word e.g. *dog/cat*.

2.1.1 Classification of individuals with aphasia

Individuals with aphasia are classified using a syndrome label to provide an outline of the aspects of language affected in a particular person and to improve communication among professionals (Swindell et al, 1984). Individuals with aphasia can be classified using categories based on the types of aphasia (see section 2.1). However, there are several difficulties regarding the use of syndromes and categories. For example:

1. Fewer than half of the patients with aphasia can be assigned with confidence to one of the standard syndromes (Goodglass, 1981).
2. According to Schwartz (1984, p. 6), evolution of the classical taxonomic scheme has taken on an "empirical, atheoretical appearance" i.e., new characteristics are discovered and added to the set of features, that may (not necessarily), be associated with the syndrome label. For a particular syndrome, the defining characteristics may include different domains like a linguistic domain in case of agrammatism, paraphasia, anomia, and a phenomenological impression of fluency or nonfluency – this results in mixing of features from unrelated domains (Schwartz, 1984; Caramazza, 1984).
3. There is inconstancy and lack of precision in feature specification while defining various syndromes. Presence of a particular feature is not essential for the classification of a particular disorder, e.g., a person with Broca's aphasia may have agrammatism and the other one may not (Goodglass, 1993). Even categories such as agrammatism and paragrammatism are not helpful as there are no pre-defined criteria for classification into these categories (Caplan, 1995).

The above listed reasons indicate the problems of assigning a syndrome category to a person with aphasia. Classification of patients into various syndromes is not a concern with more modern approaches. The next section will discuss such an approach.

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[4] The nonword produced by the patient is not related to the target e.g. *soth/cat*.

2.2 Contemporary approaches to aphasia

Contemporary approaches to aphasia include the use of models and theories to interpret disorders and to structure intervention. A theory is a "relatively more formal set of principles and a model is a less formal or as yet unproven set of ideas" (Horner et al., 1994, p. 135). An example of a contemporary approach to aphasia is cognitive neuropsychology (CNP). Cognitive neuropsychology examines the cognitive abilities of brain damaged patients to "learn more about the nature of the mental processes responsible for our ability to perform basic cognitive activities, for example, understanding and producing language" (Coltheart, 2001, p. 118). In addition, CNP uses the experimental data to confirm or falsify the underlying theory. Generally, in a model-based intervention, the intervention is based on a model of that particular linguistic ability (e.g., naming, sentence production). Examples of such intervention are prevalent for noun retrieval (e.g., Raymer et al., 1993), verb retrieval (Mitchum & Berndt, 1994) and for sentence production (Mitchum & Berndt, 1994).

The advantage of modern approaches (e.g., the CNP approaches to aphasia) is that such approaches are concerned with identifying the level of impairment in an individual in terms of a model of normal cognitive functioning irrespective of the type of aphasia that an individual may have. However, two individuals with the same symptom (e.g., difficulty in producing sentences) may have different factors responsible for the clinical symptom of poor sentence production. This may be because of additional levels of impairment within a model of sentence production or additional unidentified factors that play a role in a particular individual. Defining the impairment level within a model of sentence production does not necessarily define the intervention to be used (e.g., Basso and Marongolo, 2000).

A number of researchers have pointed out several strengths and limitations of applying CNP models to the discipline of clinical aphasiology.

2.2.1.1 Strengths

Model-based approaches can be used clinically for the following purposes:

- To diagnose the nature of a patient's language disorder (Ellis, Franklin & Crerar, 1994, p. 301)

- To conceptualise a language disorder in terms of processes (Holland, 1994)
- To find the locus of functional impairment (Hillis, 1993)
- To provide feedback to patients (Ellis, Franklin & Crerar, 1994, p. 301)
- To focus treatment (Ellis, Franklin & Crerar, 1994, p. 307)
- To establish a theoretical rationale (Basso & Marongolo, 2000)
- To predict generalisation patterns (Seron & Deloche, 1989; Thompson, 1989).

Models help in focusing the treatment by identifying the cognitive component that is impaired. In addition, the results of therapy studies can be used to influence theory-development (Riddoch & Humphreys, 1994, p. 13). CNP models are advantageous in aphasiology because they do not make prior assumptions about type of aphasia, the location of the actual brain lesion, or the "locus of impairment" in the functional cognitive system that explains the series of steps involved in understanding or producing language (Hillis, 1993). Therefore, the emphasis in intervention studies is on targeting one or more processes of a CNP model rather than on the lesion resulting in aphasia.

2.2.1.2 Limitations

Limitations of model-based approaches for application to clinical aphasiology include the following:

- A lack of specification of appropriate intervention techniques (Hillis & Caramazza, 1992, cited in Hillis, 1993; Holland, 1994, Basso & Marangolo, 2000) after the identification of a source for any given functional impairment. For example, knowing a patient's level of disruption in the sentence production model does not guide the clinician how to treat the problem. A theory of rehabilitation of cognitive function is needed to predict the changes that might occur in those processes and to know the intervention approach that would bring such a change.
- Methodological issues in terms of research and clinical applicability include the impossibility of replicating a case study (Ellis, 1987, p. 406). Heterogeneity among patients (Mitchum et al 2000, p. 316) and the

inability to replicate hinders the development of appropriate interventions for a particular impairment.

- CNP models do not explain why one patient can learn using a strategy to remediate a particular process and another with the same apparent functional problem cannot (Riddoch & Humphreys, 1994, p. 11). The lack of explanatory power occurs partly because the present models provide no analysis of motivational or other apparently ancillary factors (Riddoch & Humphreys, 1994).

2.2.2 Summary

Contemporary approaches to the study of aphasia such as model-based approaches have resulted in a deeper understanding of various disorders and functional impairments in relation to aphasia. Model-based approaches use models as their basis for explaining the normal pattern of language and normal speech errors and for explaining symptoms in brain damaged patients. The advantage of these approaches is that they do not make prior assumptions about aphasia, the type of lesion or the locus of impairment.

Despite the clinical utility of the model-based approaches in defining and specifying the locus of impairment in an individual, the intervention approach to be used is not specified by the model used. Even if the underlying impairment (i.e. the functional lesion) is the same in two patients, it is not possible to predict the same outcomes of treatment because the role of other variables such as premorbid characteristics or type of brain damage on intervention is not known (Hillis, 1993, p. 23). It is imperative to look at the effect of one specific intervention in patients with different levels of impairment within a model of sentence production.

2.3 Linguistic background

In the current study, the contribution of linguistics is in terms of the linguistic theories that explain grammar and in terms of the concepts related to verbs. This in depth knowledge of verbs and parts of sentences will help systematic planning of the intervention. Additionally, models of speech production provide a rationale for the emphasis of intervention and help in prediction of generalisation patterns. Therefore, the linguistic knowledge that informs our decisions in the current study is presented briefly in the following sections. The models of sentence production will be described in chapter 3.

2.3.1 Linguistic levels

The number of linguistic levels that are distinguished vary according to the theory of linguistics that is used: but generally, three main levels are distinguished: **phonology** (the system of the sounds of speech), **syntax** (the structural arrangement within sentences) and **semantics** (the system of meaning). The focus of the current study is syntax and will be described in detail. The description of syntax will also include the study of word structure i.e., morphology, which is usually understood to be included by the term syntax.

2.3.1.1 Syntax

Syntax is the study of the rules governing the way words are combined to form larger units, such as phrases, clauses and sentences (Crystal, 1988). In syntax, there are two main linguistic approaches: generative transformational grammars, which distinguish between the deep level and the surface level of grammatical structure and explain rules based on which utterances can be generated; and non-generative grammars that emphasise the description of the structure of utterances.

Generative transformational grammars are explanatory as well as descriptive and are popular in aphasiology, as they have stimulated hypotheses about the mental organization underlying language. Chomsky (1957, 1965) produced the original version of transformational generative grammar. More recent versions include Universal Grammar (Chomsky, 1976), Government and Binding theory (GB, Chomsky, 1981) and the Minimalist program (Chomsky, 1992). For example, Thompson et al. (1993) used aspects of GB theory from Chomsky (1981), Thompson & Shapiro (1995) used the Principles and Parameters approach of GB theory from Chomsky (1986) and in 1997, Thompson et al. used the Principles and Parameters theory from Chomsky (1991 and 1993).

A non-generative grammar which has been used as a reference for the analysis of aphasic language (e.g., Kearns & Simmons, 1983; Penn, 1988) is the *Grammar of Contemporary English* (GCE) of Quirk, Greenbaum, Leech and Svartvik (1972). GCE describes "the grammar of Educated English current in the second half of the twentieth century in the world's major English-speaking communities" (Crystal et al. 1982, p. 38). Quirk et al.'s grammar is a corpus-based reference grammar i.e. grammatical descriptions are based on actual English usage in native speakers. A decade long research study yielded a large collection of spoken utterances that formed the corpus. GCE does not aim to present a coherent theory of language structure as a whole (Crystal et al., 1982, p. 38). Rather, GCE considers different types of utterances produced by normal speakers and provides norms for spoken syntax. GCE is intended to function as a reference grammar to "find out the facts of usage in the language, the regular patterns that constitute the grammatical structure as well as the exceptions-to-rules and problem cases" (Crystal et al., 1982, p. 38).

Models of sentence production rarely specify a particular type of grammar when explaining the process of sentence production. The grammatical structure of sentences produced can be explained by both generative and non-generative types of grammar. In the current study, a non-generative grammar (i.e., GCE) is used, mainly because it is based on actual English usage in native speakers. In addition, GCE is not modified as frequently as Chomsky's grammar has been.

Morphology is defined as the study of word structure. In English, there are two kinds of suffixes: inflectional (word endings that have a grammatical role and that specify how the word must be used in a sentence but have no separate meaning, e.g., plural *–s*, past tense *–ed*), and derivational (word endings that change the word's meaning, e.g., *-ness*, *-ship*) (Crystal, 1988, p. 208). Inflectional affixes have two properties: a) individual forms are "transparent in meaning" i.e., forms like *asked* can be analysed as *ask* plus past tense, and b) they are "predictable" for regular forms i.e., one can predict the past form of an unfamiliar verb by adding –ed (Janssen, Roelofs & Levelt, 2002, p. 210). Morphology is intimately related to syntax as the word form specifies the relationship to other words in the sentence. The focus of the current study is only on inflectional affixes.

2.3.2 What is a sentence?

The focus of the current study is on sentence production and hence the following section will discuss the different parts of a sentence. According to Crystal (1996), an English sentence can "express one or more than one thought" and is "constructed according to a system of rules" (p. 29). In a sentence, the primary distinction is between a subject and a predicate. A subject relates to "what is being discussed" and a predicate refers to "something that is being said about the subject" (Quirk et al, 1972, p. 34).

According to Crystal (1996), a sentence needs to be "complete" and "grammatical" (p. 28). The length of a sentence can vary from one word (e.g. *Sorry!*) to any number of words (e.g., *I saw a cat and a dog and a car…*). Crystal, Fletcher & Garman (1976) distinguish between four types of sentences: *major, minor, elliptical major* and *reduced major* sentences. According to Crystal et al., major sentences are sentences with a subject-predicate structure (e.g., *John kicked the ball*) while minor sentences are not (e.g., *Yes. Hello. First come, first served.*) (Crystal, Fletcher & Garman, 1976, p. 44). Elliptical major sentences (e.g., T: *what's he doing,* P: *sleeping)* and reduced major sentences (e.g., T: *what's happening,* P: *man in garden*) are generally produced in response to a question. Elliptical major sentences do not include all the obligatory clause elements (but these can be recovered from the context) while in reduced major sentences, elements are left out because of the patient's inability to produce all aspects of a sentence. Furthermore, sentences can be *simple* or *complex* dependent upon the number of clauses. Simple sentences are sentences that contain only one clause while complex sentences are those that contain more than one clause.

According to GCE, a predicate can be divided into four distinct units: verb (V), object (O), complement (C) and adverbial (A). Thus, the elements of sentence and clause structure are subject (S), verb (V), object (O), complement (C) and adverbial (A) (Quirk et al, 1972). The "verb element in clause structure (V) consists of one or more verbs comprising a verb phrase" (Crystal, 1996, p. 68). The noun phrase typically functions as subject, object and complement (Quirk et al, 1972). The two main elements of interest in the current study are the verb phrase and the noun phrase.

The verb phrase can consist of a single verb, known as the main verb (e.g., *squeeze*), or be accompanied by one or more auxiliary verbs (e.g., *had squeezed*) (Crystal, 1996, p. 98). The main verb is the head of the larger phrase. Different types of verbs form the verb phrase. The verb *be* in its various forms is referred to as the copula (e.g., *the man's arm is hurt*).

A noun phrase can be simple (e.g., *the girl, she*) or complex (e.g., *the pretty girl, the pretty girl in the corner*). A simple noun phrase consists of determiner plus head or of a single noun or pronoun. A complex noun phrase (e.g., *The pretty girl in the corner is* *my sister)* can have three parts, head (e.g., *girl*), premodification (e.g., *the pretty*) and postmodification (e.g., *in the corner*).

2.3.3 Characteristics of verbs

There are three classes of verbs: lexical verbs e.g., *walk, play;* semi-auxiliary verbs e.g., *have to, be about to*; and auxiliary verbs (e.g., *do, have, be, may*) (Quirk et al, 1972, p. 69). Characteristics of verbs relevant to the current study are classification of verbs, subcategorisation frame, meaning of a verb and verb inflection.

2.3.3.1 Classification of verbs

The syntactic classification of verbs is relevant to the present study and therefore will be described here. Syntactically, verbs can be classified based on argument structure, valency or clause elements (GCE). Table 2.1 compares the three classification systems with examples. Only categories relevant to the study are listed in the table. "No category' indicates that a category in one system is not distinguished in another system.

Argument structure refers to the lexical representation of grammatical information about a predicate (Jackendoff, 1990).The categories based on argument structure are obligatory one-place verbs, obligatory two-place verbs, obligatory three-place verbs, optional two-place verbs, optional three-place verbs and complement verbs (see Table 2.1). Complement verbs are not described because they are not relevant to the study.

Every verb can occur with specific patterns of clause elements, called valency patterns. The categories based on valence patterns (Biber et al. 1999, p. 381) include intransitive verbs, monotransitive verbs, ditransitive verbs, complex transitive verbs and copular verbs.

In GCE, the overall classification for verbs is stative and dynamic. Dynamic verbs are further categorised into intensive and extensive verbs. Intensive verbs are not categorised further (p. 40). Dynamic extensive verbs are categorised as intransitive, monotransitive, and ditransitive verbs. Stative extensive verbs are categorised only into transitive category (e.g., *John knew the answer*). Dynamic verbs are used in the present study.

In the current study, the classification based on GCE is used, and two types of verbs, namely monotransitive and ditransitive verbs are used. In the GCE classification,

Table 2.1 Comparison of syntactic classifications of verbs. Optional arguments are italicized.

Argument structure (Chomsky, 1965)	**Valency (Biber et al., 1999)**	**Clause elements (Quirk et al., 1972)**	**Definition**	**Example**
Obligatory one-place	Intransitive	Dynamic intransitive	Verbs with one external argument	The boy smiles
Obligatory two-place	Monotransitive	Dynamic Monotransitive	Require 1 external and 1 internal argument	The boy catches the ball
Obligatory three-place	Ditransitive	Dynamic ditransitive	Require 1 external + 2 internal arguments	The girl gives a bone to the dog
Optional two-place	No category	No category	Verbs with an optional second argument	The woman eats *spaghetti*
Optional three-place	No category	No category	Verbs with an optional third argument	The woman throws the stick *to the dog*

the optionality and the obligatoriness of the argument are not taken into account (unlike the classification based on argument structure). However, the current study takes the optional and obligatory feature of arguments into account. All the transitive verbs (or obligatory two-place verbs) used in the current study have obligatory arguments and the ditransitive verbs used have both optional and obligatory arguments.

2.3.3.2 Subcategorisation frame

Subcategorisation frame is a term that has been taken from Chomsky's Government and Binding theory (Chomsky, 1981). Each verb in the English language carries lexical information that directly influences sentence structure. Different verbs can and sometimes must be followed by certain sentence constituents (e.g., noun phrases). For example, the verb *sleep* does not require a direct object NP, whereas the verb *hit* allows a direct object noun phrase (NP) to follow it. This phrasal (and clausal) information is known formally as *strict subcategorisation.* This information characterizes the syntactic form of the phrases or clauses a verb can take or not take regardless of semantic content (Chomsky, 1965; Grimshaw, 1990). Thus, on selection of a verb lexically, the subcategorisation frame specifies the requirements in terms of a syntactic structure for a sentence to be grammatical. Argument structure, on the other hand, is relevant both to the syntax (by characterizing the argument) and to the semantics (by forming a first-order approximation of a semantic description of a sentence) (Grimshaw, 1990).

2.3.3.3 Meaning of a verb

The meaning of a particular verb depends in part on the semantic role of the subject and the object, for example, part of the meaning of *find* in the sentence *the girl found a red brick* is that its subject is an agent or *doer* of the action and its object is the patient or *recipient* of the action. This is reflected in the entry for *find* in the lexicon (Fromkin et al, 1990, p. 216). Transformational grammar uses the term *thematic roles* or *theta roles* while GCE uses the term *semantic roles* to define the roles of the different grammatical elements of a sentence.

Thematic/Semantic role:

The different syntactic elements of a clause have a semantic role. For example, a subject occurs with all types of verbs and is characteristically a noun phrase and often denotes an agent, i.e., the willful initiator of the action. The causal agent is often the subject. If the actor does not cause an event, it is not an agent. This is exemplified in sentences such as *the child wept* and *Henry took the train,* where *child* and *Harry* are actors but not agents. *Child* is the *experiencer* and *Henry* is the *recipient* of the *theme train.*

The abstract roles (e.g., *agent, recipient* etc.) that the arguments of a verb fulfill in a conceptual structure are known as thematic roles and the distribution of roles within a message is called its "thematic structure" (Levelt, 1989, p. 89). According to GCE, semantically, the different clause elements represent participants in an event or state (Quirk et al, 1972, p. 358). The semantic roles of the different elements of a clause relevant to the current study are listed in Table 2.2.

2.3.3.4 Verb inflection (the morphology of lexical verbs)

A lexical verb has five forms: the base, the –s form, the past –ed form, the –ing participle form and the –en past participle form (Crystal et al., 1982). Examples are *show, shows, showed, showing, shown*; *call, calls, called, calling, called.* The base form is also used as an infinitive (Quirk et al., 1972, p. 104).

Regular lexical verbs (e.g., *walk, ask*) are called regular because all the forms of the verb besides the base can be predicted if the base is known (Quirk et al, 1972, p. 106). Irregular verbs have their –s form and –ing form predictable from their base but not their past form. Irregular verbs may have a variation in their base vowel (e.g., *find, found*) and they have a varying number of distinct forms (e.g., *cut/cut/cut, meet/met/met, come/came/come* etc.).

Irregular verbs constitute a very small proportion of the entire set of verbs and they are mostly of very high token frequency. The regular class has by far the highest type frequency (Bybee, 1995, p. 426).

Table 2.2 Examples of semantic/thematic roles (Quirk et al., 1972; Levelt, 1989).

Clause element	Semantic role	Example
Subject	Agentive i.e., causes the happening	John opened his eyes
	Instrumental	The avalanche destroyed several houses
	Theme	The ball is in the garden
	Recipient	They have a beautiful house
Direct object	Affected participant	I've broken a plate
	Recipient	We rewarded John
	Locative	He climbed a mountain
	Theme	The woman threw a ball to the boy
	Patient	John hit Don
Indirect object	Recipient i.e., passively implicated by the happening	I've found you a plate
	Affected	She gave her hair a brush(ing)
Complement	Attribute of the subject	He seems unhappy

Theories of past-tense formation:

There are two competing theories used to explain past tense formation in terms of the relation between the mental lexicon and the mental grammar: *dual-system* theories and s*ingle-system connectionist models*.

Word sounds and meanings are stored in either rote or an associative memory. According to the dual-system view, irregular past-tense forms (*blew*) are retrieved from memory, so they are expected to be frequency sensitive, with high-frequency forms being easier recalled than low-frequency forms. Regular-past tense forms (*walked*) are rule-produced in real-time, so they should show no such frequency effects once access to their stem forms (*walk*), to which the *–ed*-suffixation rule is applied, is controlled for (Pinker, 1999; Ullman, 1999; Patterson, Ralph, Hodges and McClelland, 2001).

A contrasting view (i.e., connectionist model), framed in terms of parallel distributed processing (PDP), argues that all classes of past-tense transformation are achieved by a distributed, constraint-satisfaction process recruiting activation of the phonological and semantic representation of words. This account is based on the model of past tense formation by Rumelhart and McClelland (1986). Regular and irregular verbs do not have separate rule-governed and lexical-associative mechanisms but are different in terms of the sharing of connection-weight support that is present only for regular verbs (Patterson, Ralph, Hodges and McClelland, 2001).

2.3.4 Characteristics of nouns

Nouns can refer to animate (living) beings and to inanimate (non-living) entities. Animate beings can be divided into personal (people) and non-personal (animals) (Crystal, 1996, p. 125). The two main types of nouns are common (e.g., *cow*) and proper nouns (e.g., *Jack*). Characteristics of nouns relevant to the current study include case and syntax and semantics of nouns.

2.3.4.1 Case

Case is a grammatical category that can express a number of different relationships between nominal elements. The case system shows how a noun relates to other nouns, or how the noun phrase is being used within a clause. English nouns have a two-case system: the unmarked common case (*boy*) and the marked genitive case (*boy's*). The chief meaning of the genitive case is possession (e.g., *my son's wife, the man's arm*). All animate nouns can take a genitive inflection and some inanimate nouns can also take a genitive inflection (e.g., *the car's engine, the book's title*) (Quirk et al., 1972, p. 201). Only nouns that take a possessive genitive are included in the current study.

2.3.4.2 Syntax and Semantics of nouns

Noun phrases have a wide range of syntactic roles such as subject, direct object, and indirect object. A noun has a vast semantic range and can be used to name a person, place, thing, idea, or time. Nouns are typically associated with semantic roles such as agent, affected and the recipient (see Table 2.2, section 2.3.3.3).

The role that a noun plays in a sentence is dependent on the verb and on the type of noun. For example, in the sentence *the door opened,* the grammatical role of *door* is subject and the semantic role of *door* is patient. A differentiation is made between a grammatical subject and a logical subject. A logical subject is used to refer to a participant that is not the grammatical subject but which has a semantic role of agent in a passive sentence (e.g., *Bob* in the sentence *this door was opened by Bob*).

2.4 Linguistic analysis of speech

Different aspects of an individual's speech (or language or language behavior) can be analysed linguistically (e.g., phonology, syntax and pragmatics). The emphasis here is on syntax. A language sample from an individual can provide important information regarding the grammatical structures that the individual can and cannot use. In the normal population, linguistic analysis has been carried out to determine the grammatical structures normal speakers produce in everyday conversation and to compare their responses under different speaking situations such as narration, interaction etc. (Golinkoff & Ames, 1979; Blake, Quartaro & Onorati, 1993).

Spontaneous samples are obtained using different elicitation procedures such as using situational pictures (e.g., *Cookie theft*) and story-elicitation procedures (e.g., *Cinderella*). Each elicitation procedure has its benefits. For example, story elicitation procedures provide a context for interpretation of patients' utterances (e.g., Saffran et al., 1989). We believe that spontaneous samples elicited using situational pictures (e.g., Nicholas & Brookshire, 1993) would reflect a close approximation to the process of sentence production in conversation because the person would have to think and form a sentence depending upon what they wanted to talk about in the picture. In individuals with impaired language, a detailed analysis of samples of language behavior can provide important information regarding the linguistic characteristics of the disability of an individual patient and suggest areas that need to be emphasised in the rehabilitation process.

Analysis of speech in patients with aphasia: An important aspect of rehabilitation of patients with impaired language is spontaneous speech. Most of the intervention studies in the area of sentence processing analyze the spontaneous speech of their participants, generally to see if there is any generalisation from the trained elements to their spontaneous speech or if the training has affected the spontaneous speech in any way.

Different procedures for analysing spontaneous speech are reported in the aphasiology literature. These procedures differ in their focus, in the underlying theory and in the segmentation units used to analyse the speech samples. Table 2.3 briefly describes the procedures used in the literature highlighting the differences in the focus of the different procedures.

Linguistic theory: The procedures differ in terms of the linguistic theory that forms the basis for the analysis. Three of the procedures listed in Table 2.3 use versions of Transformational grammar (Chomsky, 1957). For example, Saffran et al. (1989) analyse sentences into verb phrases and noun phrases; Byng and Black (1989) evaluate predicate-argument structures and Thompson et al. (1995) analyse argument structure. In contrast, the Reading scheme (Edwards et al., 1993) and LARSP (Crystal et al., 1976) use A Grammar of Contemporary English (GCE, Quirk et al., 1972). The Reading Scheme (RS, Edwards, Garman & Knott, 1993) focuses on the relationship between clausal and phrasal units. LARSP emphasizes functional relationships between the different elements of structure at clause level (Crystal, Fletcher & Garman, 1982, p. 39). Nicholas and Brookshire (1993) had a different emphasis and they looked at relevance, accuracy, intelligibility and information in relation to the content of the picture.

Segmentation: There is no universally accepted method of segmenting a speech sample into a particular unit for analysis. Segmentation criteria used by researchers in the normal population are different from the ones used to analyze speech in the brain-damaged population. Segmentation criteria used in the normal population are utterances (Golinkoff & Ames, 1979; Crystal, Fletcher & Garman, 1976) and usable utterances (e.g., Blake et al., 1993) (see Table 2.4). The segmentation units used to segment aphasic language in the literature are reasonable units (Wagenaar et al., 1975), content units (Yorkston & Beukelman, 1980), verbalizations (Glosser, Wiener & Kaplan, 1988) sentences (Saffran, Berndt & Schwartz, 1989), text-units (Edwards et al., 1993), correct information units (Brookshire & Nicholas, 1994a) and clause like semantic units (Singh & Bookless, 1997).

Table 2.3 Procedures used to analyse spontaneous speech.

Name	Procedure
Quantitative production analysis (QPA, Saffran et al., 1989)	• Analyses the first 150 words of a narrative sample • Morphological content and structural complexity • Uses narration of fairy tale
Byng and Black's Coding system (Byng & Black, 1989)	• Analyses syntactic realization of predicate-argument structures • Differentiates production of arguments and non-arguments • Uses narration of fairy tale (same as Saffran et al., 1989) • Describes utterances in terms of 28 categories
Thompson's coding system (Thompson et al., 1995)	• Proposes an analysis system to quantify aspects of verbs and their lexical entries in sentence production • Analyses utterances and codes verbs based on their argument structures
Reading scheme (Edwards, Garman & Knott, 1993)	• Focuses on lexical-syntactic features of connected speech • Relationship between clausal and phrasal units
Correct information unit (CIU) analysis (Nicholas & Brookshire, 1993)	• Analyses connected speech in response to 10 elicitation stimuli • Five measures: number of words, number of CIUs, words per minute, percent CIUs and CIUs per minute
Language Assessment Screening and Remediation Procedure (LARSP, Crystal et al., 1976)	• Analyses speech samples at three different levels: clause, phrase and word level • This can be supplemented by extra analyses using computerized profiling (CP) (see Appendix D, section D.2) – Verb-valency analysis, Verb-form analysis and Lexical analysis

Table 2.4 Segmentation units identified in the literature

Researcher	Segmentation unit	Definition used
Golinkoff & Ames (1979) (normal verbal interaction)	Utterances	A word or string of words identified by a pause or by grammatical completeness
Blake, Quartaro & Onorati (1993) (used in normal children)	Usable utterance	An utterance containing not more than one doubtful word and no unintelligible words
Wagenaar et al. (1975) (aphasic language)	Reasonable units	Syntactic criteria primary, melodic criteria secondary
Crystal, Fletcher & Garman (1976) (normal and aphasic language)	Utterances	Stretches of spoken language, used without a break by a single person, capable of being formally characterized in some way (Crystal, 1969, p. 277).
Yorkston & Beukelman (1980) (aphasic language)	Content units	Grouping of information expressed as a unit by normal speakers
Glosser, Weiner & Kaplan (1988) (aphasic language)	Verbalizations	Syntactically complete, prosodically identifiable
Saffran et al. (1989) (aphasic language)	Sentences	Falling intonation and a well-formed sentence
Edwards et al. (1993) (aphasic language)	Text units	Minimal one word and maximal a clause
Brookshire & Nicholas (1994a) (aphasic language)	Correct information units	Words intelligible in context, accurate and relevant to the picture
Singh & Bookless (1997) (aphasic language)	Clause like semantic units	Cohesive string of words, self-contained information

LARSP: LARSP is a procedure designed to analyse both adult and child language (Crystal et al., 1976, p. 23). LARSP uses a performance-based grammar (e.g., GCE, Quirk et al., 1972) derived from the speech of actual speakers. The aim of LARSP is to be able to find a place for everything that a person says (Crystal, Fletcher & Garman, 1982). LARSP has been used to quantify aphasic speech (e.g., Kearns & Simmons, 1983; Penn, 1988). One of the advantages outlined by Kearns and Simmons (1983) is that it is based on a surface structure analysis and there is a minimum of theoretic assumptions associated with it. According to Penn (1988), LARSP accounts for the complete range of expressive syntax.

Saffran et al. (1989) suggest that two major problems arise when this procedure is applied to aphasic data. The first problem surrounds the difficulty of segmenting the sample into analyzable utterances. The second problem is that LARSP does not provide a mechanism for comparing different patients. We believe that these two problems can be resolved. The first problem can be resolved by using detailed criteria to ensure consistent segmentation. The second problem can be resolved by making a comparison between two LARSP samples in terms of the different features that are present (e.g., in terms of the number of clauses at the different stages of the LARSP chart), or by carrying out a lexical analysis or a verb valency analysis to supplement the information summarized in the LARSP chart (see Appendix D, section D.2).

2.5 Summary

Chapter 2 focused on four main areas related to the present study: a) types of aphasia; b) approaches used to study sentence production; c) linguistics and d) linguistic analysis of speech. The current study uses a cognitive neuropsychological approach for sentence production disorders in patients with aphasia. The CNP approach involves the use of a cognitive psychology model to provide a theoretical rationale for the proposed intervention. In addition, the current study integrates information from linguistics regarding characteristics of verbs and nouns. Researchers have proposed different models of sentence production to explain how an individual forms a sentence. These models of sentence production are described in Chapter 3.

3 Chapter Three: Models of sentence production

Models of sentence production in the normal population have been applied to the diagnosis and the treatment of impaired language (e.g., patients with aphasia). A theory of normal language processing provides a basis for predicting how various stimuli will influence processing, and provides a rationale for manipulating the stimulus complexity over the course of intervention (Mitchum, 1991). The current study uses a model of sentence production to define different levels of intervention and to predict generalisation patterns. This chapter describes the models of sentence production (Garrett, 1975, 1984; Levelt, 1989, 1999; and Bock and Levelt, 1994) in the literature.

3.1 Models of sentence production

Several models that try to explain the process of normal sentence production exist in the literature. For a normal person, a model of sentence production should be able to account for features of speech production such as the ability to produce the right words to explain what we mean, i.e., the selection of lexical items. Features of speech production would also include the ability to produce grammatically correct sentences, i.e., with the right inflection and concord agreement; the ability to produce the same sentence in different grammatical ways such as active, passive etc. (i.e., syntactic flexibility), and the ability to produce both simple and complex sentences.

Most of the models are restricted to only one aspect of sentence production e.g., selection of affixes or grammatical encoding. This section will describe the models of sentence production by Garrett (1984) and by Levelt (1989) and the modifications of these models by Bock and Levelt (1994) and by Levelt et al. (1999). These models are also known by other names such as *frame model, slot and filler model.* Although there are many other models (e.g., Dell, 1986), the focus of the current study is on discrete models of sentence production and hence only models related to Garrett's model in particular will be described in detail in the following section. Dell's model is not used in the current study because the spreading-activation theory of retrieval in sentence production (Dell, 1986) focuses on phonological encoding, particularly the retrieval of phonological forms, and does not include explicit models of syntactic[1] and morphological[2] encoding. The emphasis of the current study concerns aspects of syntactic and morphological encoding that are covered by Garrett's model.

3.1.1 Origin of Garrett's model

Garrett's model has similarities to Luria's model of speech production (1947/1970) in that Luria emphasised the formation of plans for speech. The notion of a schematic formulation of a sentence existed as early as Pick (1913/1994b). Two models, one by Fry (1969/1973) and the other by Fromkin (1971/1973) are also based on speech errors. These models have some similarities to Garrett's model and therefore will be briefly described here.

3.1.1.1 Fry's model

In 1969, Fry proposed that the programming of utterances has five levels (p. 158): semantic encoding (thinking what we want to say), lexical encoding (the selection of words based on the intention of the speaker), morpheme encoding (selection of the necessary affixes), phoneme encoding (programming of the sequence of phonemes in accordance with the morpheme string) and motor control (instructions to the muscles). Fry thinks of "the five programs as being each on a moving belt with its own drive; as the generation of a message proceeds, the programme on one belt may move up on or lag further behind the one above" (p. 159).

3.1.1.2 Fromkin's Utterance generator

Fromkin (1971/1973) presented a model of linguistic performance based on speech errors. Fromkin suggests five stages in the actual generation of an utterance (p. 239). The stages are summarised in Table 3.1. For a complete outline, see Figure 3.1.

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[1] According to Dell (1986), syntactic encoding means selection of words and imposition of word order according to the rules of the grammar of the speaker's language.

[2] According to Dell (1986), morphological encoding is the specification of the words in terms of their constituent morphemes.

Table 3.1 Stages of sentence production

Stage	Processes
1	Generation of a meaning to be conveyed
2	Syntactic structure and buffer storage
3	Specification of word slots and sentence intonation contour
4	Lexicon look-up, matching of semantic features and specification of directional address
5	Automatic phonetic and phonological rules

3.1.2 Garrett's model

Garrett's model is based on speech errors from the spontaneous speech of normal speakers. Analysis focuses on those errors in which the specific target of the utterance is quite clear, but the speaker misorders the elements or substitutes some other element for an intended one.

According to Garrett (1984), there are five levels in the process of producing a sentence, the message level for general conceptual processes, the functional, positional, and phonetic levels for sentence processes, and the articulatory level for motor control processes. According to Garrett, different processes are in use at the five levels of sentence production (1984, p. 172). At the message level, inferential processes are used. At the functional level, logical and syntactic processes are used. At the positional level, syntactic and phonological processes are used. At the phonetic level, phonological processes are used. The articulatory level involves motor coding. Garrett separates the production processes into a conceptual system for message construction and a language specific system for sentence construction (Garrett, 1993). His focus is on the sentence level of processing. His analysis is mainly concerned with processes of *lexical selection* and *phrasal construction.*

The five different levels in Garrett's (1984) model are as follows:

3.1.2.1 Message level

The message (M) is the real time representation that controls the integration of sentence form, and thus expresses the speaker's communicative intent at the time of utterance. The message level feeds only to the functional level.

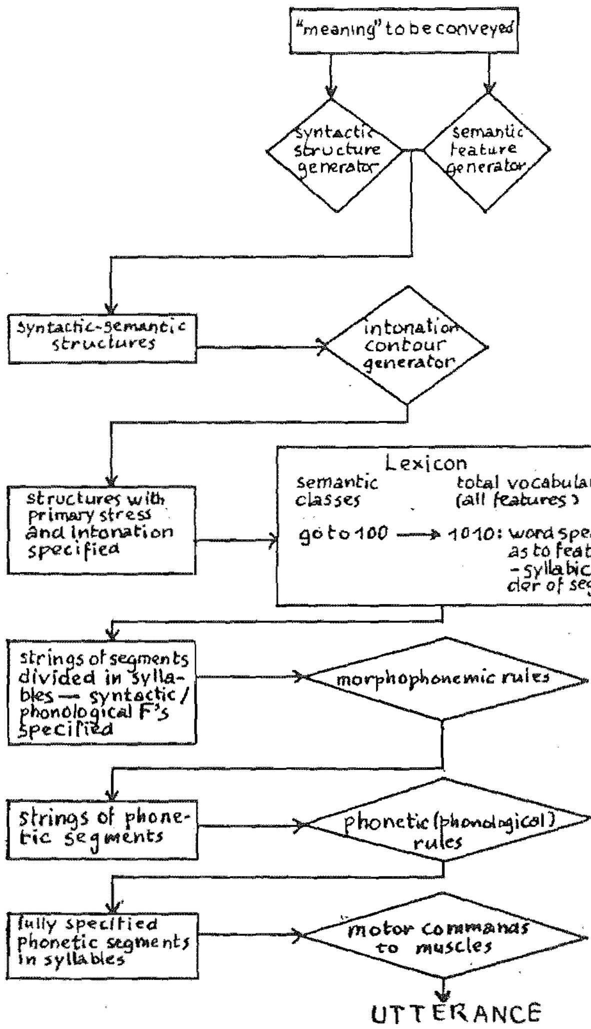

Figure 3.1 Utterance generator. From "The non-anomalous nature of anomalous utterances" by V. Fromkin, 1973, The Netherlands: Mouton. Copyright 1973 by Mouton De Gruyter. Reprinted with permission.

3.1.2.2 Functional level

The functional level is a multiphrasal level of planning, in which the assignment of major lexical-class items to phrasal roles is accomplished. On the basis of meaning relations, lexical selection takes place and the lexical concept is retrieved in the form of a lemma[3] (a non-phonological entity that specifies the meaning and the syntax of a lexical concept). Based on the lemma, the functional structures (i.e., agent, patient etc.) are specified and lexical elements are assigned to structural role positions (e.g., subject, object etc.) (see Figure 3.2). Open class (OC) elements[4] are recruited by direct retrieval processes – i.e., under message structure control (inferable from word substitution errors).

3.1.2.3 Positional level

At the positional level, word forms are retrieved and a planning frame is selected. This planning frame consists of features and slots (see Figure 3.3). Both bound and free morphemes are already there in the form of features and the lexical items are inserted in the slots. The phonological forms for the selected lexical items are specified, as are the phrasal level constituents (subject noun phrase, verb phrase etc.).

In Garrett's words,

> the translation from the functional to the positional level represents a transition from a logic-oriented to a pronunciation-oriented representation. Its properties include retrieval of the segmental structure of lexical items, determination of surface phrasal geometry, assignment of lexical formatives to phrasal positions, and interpretation and siting of grammatical formatives in the surface sequence of sentence elements (Garrett, 1984, p. 177).

The positional level is construed as a single-phrase planning level (based on sound exchange errors that are phrase internal). A single-phrase planning level means that the unit of processing at a particular moment in time is a single phrase i.e. the processes would involve a single phrase.

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[3] This term was originally coined by Kempen and Hjuibers (1983) and was adopted by Garrett in his later version (e.g., 1984).

[4] Open class words consist of nouns, adjectives, adverbs and verbs.

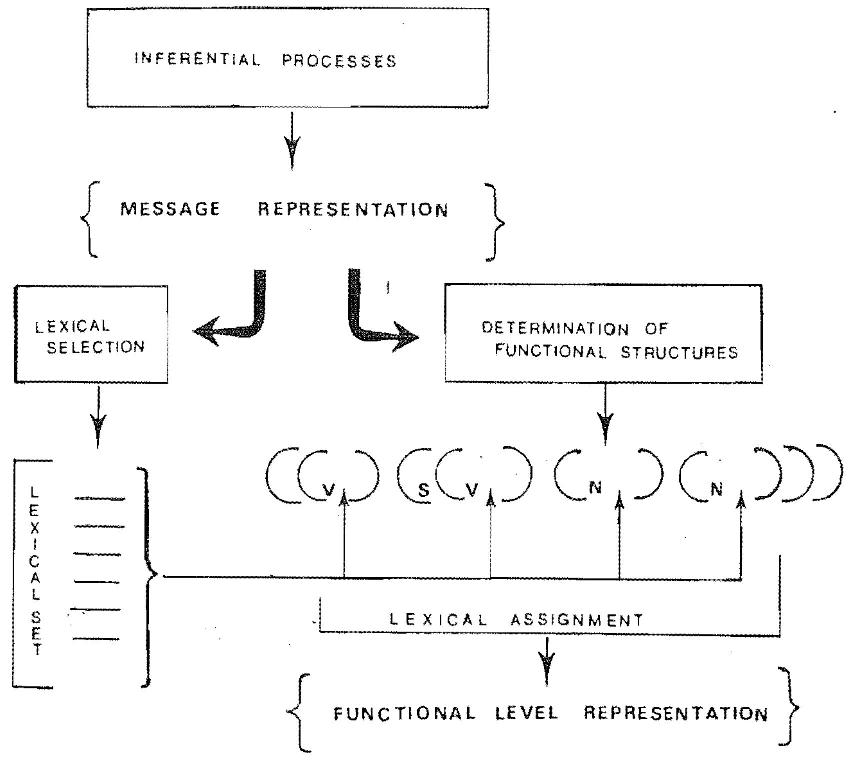

Figure 3.2 Processes in sentence production at the functional level in Garrett's model of sentence production. From "The organisation of processing structure for language production: Applications to aphasic speech" by M.F. Garrett, 1984, Massachusetts: The MIT Press. Copyright 1984 by the MIT Press. Reprinted with permission.

The closed class elements[5] are recruited as part of structural frames, particularly planning frames, associated with phonological phrasing (Garrett 1975; 1980). Closed class elements are not on the lexical list and are instead assumed features of the frames (Garrett, 1984).

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[5] Closed class words comprise of articles, demonstratives, pronouns, prepositions, conjunctions and interjections. For the present study, inflectional affixes are considered a part of the closed class vocabulary.

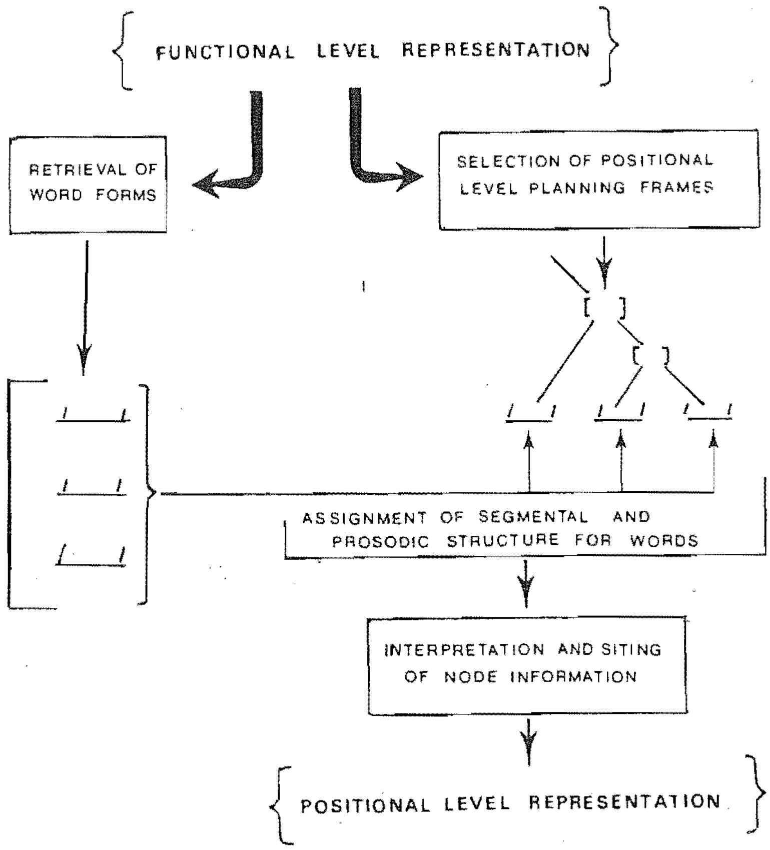

Figure 3.3 Processes in sentence production at the positional level in Garrett's model of sentence production. From "The organisation of processing structure for language production: Applications to aphasic speech" by M.F. Garrett, 1984, Massachusetts: The MIT Press. Copyright 1984 by the MIT Press. Reprinted with permission.

3.1.2.4 Phonetic level

Specification of phonetic detail via regular phonological processes takes place.

3.1.2.5 Articulatory level

The sentence-level structures are translated into instructions for control of the respiratory and articulatory systems.

3.2 Speech errors

Different types of speech errors from the spontaneous speech of normal speakers form the basis for Garrett's model of sentence production.

According to Garrett (1975), the argument is that if speech error patterns are taken to reflect normal processing structure, the properties of error types and their interactions should tell us what structures are being computed by the system at given points in the elaboration of a sentence.

Garrett explains the five levels he postulates by saying, "the constraints on the errors that characterise the processing levels are disjoint" (Garrett, 1993). Word-exchange errors (e.g., *...see if your week's clear in an eye* [*...your eye's clear in a week*] (Garrett, 1993, p. 79)) are between phrases, whereas sound exchanges (e.g., *I was just gonna rock on the nong door* [*knock/wrong*] (Garrett, 1984, 177)) are within phrases. Word exchanges are not constrained by morphological structure or by segmental and prosodic similarity, whereas sound exchanges and most stranding errors (e.g., *That's why they sell the cheaps drink* [*drinks cheap*] (Garrett, 1993, p. 80)) are so constrained. Word-selection processes are constrained by vocabulary type, both with respect to syntactic and phonological roles and with respect to meaning and form.

3.2.1.1 Support for a functional level

The contrast between word exchanges (e.g., *We'll sit around the song and sing fires* [*fire and sing songs*]) and sound exchanges (e.g., *...got a lot of pons and pats to wash [pots and pans]*) indicate a processing stage, prior to the sound structure level. This stage is distinct from the message level (i.e., another level apart from the message and the sound structure level), and has been called the functional level. At the functional level, the syntactic relations among words, but not their surface phonological representations are determined. The functional level is a multiphrasal level because word exchanges occur between phrases or between adjacent clauses. It has a two-clause limit because word exchanges rarely involve elements of nonadjacent clauses.

3.2.1.2 Support for a positional level

According to Garrett (1984), several properties of sound exchange errors suggest important features of the representations being constructed at the positional level.

a) Strong phonological similarities between the interacting sound elements themselves and between the immediate segmental and syllabic environments of the exchanged elements reinforce the claim that abstract phonological information is present
b) The majority of such errors occur within phrases and the source syllables are metrically similar i.e., the level at which these processing errors occur is constrained by phrasal boundaries (Garrett, 1984, p. 163).

Sound errors are phrase internal and so the processes at the positional level involve single phrases.

3.2.1.3 Support for a phonetic level

Accommodation errors (e.g., *an angwage lacquisition device [a language acquisition device]*; a/an alternation) show that at the points of shift errors and sound exchanges (processes that are taken to be diagnostic of positional-level processes) the phonetic character of elements subject to regular phonological processes remains to be specified. This therefore indicates that there is another level that specifies the phonetic character of elements and this level is known as the phonetic level.

Error patterns suggest a planning process in which sentence elements are assembled phrase by phrase. However, an error that spans a particular string does not imply that there is a simultaneous representation of all the elements of the sub-string or even that they are in construction. For example, in a sentence, *We expect Jom and Terry to be there (intended: Tom and Jerry),* the substring '*Tom and Jerry*' is not simultaneously represented and is not in construction at the same time. Exchange errors may span one to several words in the intended sentence – this does not mean that the full string of elements spanned is also present (Garrett, 1993, p. 182).

<u>3.2.2 Advantages and disadvantages of Garrett's model</u>

An advantage of Garrett's model is that it is based on real language data. It adequately explains the overall process of how a sentence is produced by postulating five different levels. However, Garrett's model fails to explain how a planning frame is selected and how the various affixes are selected at the positional level. In addition, the various steps that take place for each feature at a particular level (e.g. the nature and organisation of processes that carry out function assignments) are not specified. Moreover, the model's syntactic processing levels are never explicitly related to the grammatical levels of a particular linguistic framework, though the processing levels are paralleled to the levels of deep and surface syntactic structure[6] in standard transformational theory (Chomsky, 1965, 1981). For example, the output of the positional level is correlated with surface structure (e.g., Levelt, 1989, p.11). The specification of thematic roles at the functional level can be correlated to deep structure.

3.3 Lapointe & Dell's (1989) model

Lapointe & Dell's (1989) model is the only model that explains selection of affixes in detail and differentiates the retrieval of inflectional affixes from that of function words. The main purpose of explaining Lapointe & Dell's model is to describe the processes involved in the selection of affixes that are not elaborated upon in Garrett's model. Selection of affixes corresponds to the planning frame in Garrett's model.

Lapointe & Dell (1989) provided an Extended Garrett's (EG) model in which they made some assumptions about the components of the syntactic processor to explain how affixes are selected. Their model is based on an analysis of auxiliary and verb form productions in the speech of English and Italian speaking agrammatic aphasics. According to them, the syntactic processor consists of a control mechanism, a notion store, a fragment store and a stem inserter. The control mechanism analyses the functional level representations and accesses fragments via notion stores from the fragment stores. The fragment stores consist of two types of fragments, phrase fragments and function word fragments. The phrase fragment is similar to the structure of a verb phrase according to X-bar theory (Chomsky, 1986, 1992)[7]. The notion stores are of two

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[6] D-structure captures the underlying relationships between subject and object in a sentence. S-structure captures the surface linear arrangement of words in a sentence (GB theory, Chomsky, 1981)

[7] One of the principles proposed by Chomsky in his Principles and parameters approach is called X-bar theory (Chomsky, 1986). According to X-bar theory, all phrase structures have the same form: an XP

types, a VP (verb phrase) notion store and a NP (noun phrase) notion store. These notion stores contain the semantic notions typically associated with function words and inflections, for example, auxiliaries for verbs and determiners for nouns. The semantic notions for function words and inflections associated with a verb would be the meanings associated with tense, aspect, modality etc. and for a noun, an example would be the meaning associated with a determiner (e.g., *the* means that the referent is assumed to be known to the speaker and the addressee). The function word fragments contain a single function word category node like *was* (here *was* is an auxiliary verb) for a verb or *the* for a noun. Phrase fragments contain a slot for the head stem to be filled in by material retrieved from the lexicon. Once the fragment is selected, the affix or the function word gets selected and its stem is inserted into the appropriate slots in the combined fragments by the stem inserter. According to Lapointe & Dell,

> the lexical retrieval system is not concerned with accessing function words, since these are already present in their own syntactic fragments which are stored and accessed separately, but concentrates instead on the problem of retrieving a single major lexical item for each phrase fragment being processed (p. 114).

Lapointe and Dell describe spreading network activation where activation of the fragment leads to activation of the lexical concept node resulting in activation both upward and downward.

This model is not directly compatible to the model used in this thesis as, unlike the model proposed here, it uses 'spreading network activation' and X-bar theory. The components of the syntactic processor are hypothetical and do not relate to a particular area in the brain. The main point to be noted is that Lapointe & Dell differentiate between the retrieval of inflectional affixes and function words. The inflectional affixes are retrieved directly from the phrase fragments.

3.3.1 Summary

The important point from Lapointe and Dell's model is that inflectional affixes are retrieved separately from function words, in contrast to Garrett's model where both

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(maximal projection), X'(s) (intermediate projections), a head X (a lexical category), a complement (ZP) of the head that is on the same phrasal level as the head, a specifier position, and perhaps an adjunct phrase (modifier; YP) that can attach above the head.

inflectional affixes and function words are represented and processed in a uniform way in production.

3.4 Levelt's model

This section briefly describes Levelt's (1989) view of the processes involved in the generation of fluent speech. The main purpose of describing Levelt's view is, first, to explain about lemmas and, second, to explain more about the conceptualizing stage, which corresponds, to the message level in Garrett's model.

The term 'lemma' was introduced by Kempen and Hjuibers (1983) and used by Levelt (1989) for the nonphonological part of an item's lexical information. A lexical item is a complex entity and is

> retrieved based on its meaning and the syntactic environment in which it occurs. When it is said that a speaker has retrieved a lemma, it means that the speaker has acquired access to those aspects of a word's stored information that are relevant for the construction of the word's syntactic environment (Levelt, 1989, p. 6).

Levelt's model consists of three processing components called the conceptualizer (corresponds to the message level), the formulator (corresponds to the functional, positional and phonetic levels in Garrett's model) and an articulator. The formulator translates a conceptual structure into a linguistic structure with two processes, called grammatical encoding and phonological encoding. Grammatical encoding comprises of selection of appropriate lexical concepts and the building of a syntactic framework. The function of phonological encoding is to retrieve or build a phonetic or articulatory plan for each lemma and for the utterance as a whole (Levelt, 1989).

Levelt lays great emphasis on the component called the 'conceptualizer' in his model that corresponds to the message level. He describes two main terms: macroplanning and microplanning in the context of speech planning. The speaker's planning of a speech act, his selection of information to be expressed, and his linearization of that information are called 'macroplanning' (Levelt, 1989). Microplanning involves the addition of 'propositional shape' and 'perspective' to the intended expression. One and the same event can be propositionalized as the mother giving an ice cream to the child, or as the child receiving an ice cream from the mother. These perspective relations have to be specified in the speaker's conceptual preparation of speech, because they are important determinants of word choice (*give, receive*), and of the assignment of grammatical roles (*the mother* as subject of the sentence *or the child*). Microplanning also involves the assignment of an 'accessibility status' to the referents in a proposition (i.e. whether an anaphoric reference can be made)[8] and certain language-specific decisions. For example, English has a tense system and it is obligatory to specify the relevant temporal relations, even if they do not contribute to conveying the speaker's intention. By contrast, in Chinese languages that do not have tense as an obligatory feature, the speaker will plan for the expression of temporal relations where they are relevant for conveying his intention (Levelt, 1993, p. 3). The eventual output of a speaker's conceptual preparation is technically called a 'message'. Levelt's description emphasises the importance of the message level and the various types of information (propositional shape, perspective, accessibility status and language-specific decisions) conveyed to the functional level that result in the intended utterance.

3.5 Bock and Levelt's model

Bock & Levelt (1994) expanded Garrett's model by explaining in detail the various processes that take place at the different levels (e.g. lexical access, function assignment).

The assumptions made in Bock and Levelt's model are the same as the ones made in Garrett's model. These assumptions are (Bock & Levelt, 1994, p. 949):

a) Each processing sub system is influenced only by information represented at the level directly above it (i.e., the flow is from top to bottom). For example, Bock and Levelt assume that the processes of lexical selection and function assignment are under the control of information in the message and are unaffected by the sounds or phonological features of words.
b) Language production is incremental i.e., higher levels (top) need not complete their work on an utterance before the next level begins. Bock and Levelt's model permits

[8] If the mother in the above proposition had already been mentioned in the previous sentence, she is likely to be in the focus of the addressee's attention. Knowing this, the speaker gives her a high accessibility status, which means that reduced or anaphoric reference can be made (e.g., *She gave the ice cream to the child*).

incremental production by building pieces of phrase structure as the lemmas and function assignments that demand particular phrasal fragments become available.

Bock and Levelt describe four levels: message, functional, positional and phonological (same as the levels in Garrett's model). The emphasis of their model is on the 'grammatical encoding' part, so they discuss only the functional and positional levels in detail. Grammatical encoding comprises both the selection of appropriate lexical concepts (entries in the speaker's vocabulary) and the assembly of a syntactic framework. Only features in addition to Garrett's model will be described here.

3.5.1 Message

As in Garrett's model, the message captures features of the speaker's intended meaning and provides the raw material for the processes of grammatical encoding (Bock & Levelt, 1994, p. 946).

3.5.2 Functional

The primary subcomponents of functional processing are lexical selection and function assignment. This description is similar to that of the functional level in Garrett's model.

3.5.2.1 Lexical selection

Bock & Levelt describe in detail the process of lexical access at the point of lexical selection (in comparison to Garrett's model). They focus only on stored words that are retrieved from the mental lexicon and do not take into consideration productive lexical encoding (i.e., words that are constructed when needed, for example, *twenty-three thousand two hundred seventy nine*). According to them, knowledge of words involves three types of information a) the word's meaning (*the concept*), b) the word's syntactic properties (*the lemma*) and c) the word's form properties (*the lexeme*). The lexeme captures the word's form properties and comprises of the word's morphological and phonological shape. For example, the word 'sheep' is monomorphemic and consists of three phonological segments /ʃ /, /i/ and /p/. The word 'handing' consists of two morphemes, a stem and a suffix, and six phonological segments, /h/, /æ/, /n/, /d/, /ɪ/ and /ŋ/ (Bock & Levelt, 1994, p. 951).

Bock and Levelt use spreading activation to explain the lexical retrieval part of sentence production. According to a network model of lexical access, different types of information (e.g. the meaning of a word, the syntactic properties of a word and the word form properties of a word) correspond to nodes within three levels of representation, the conceptual level, the lemma level and the lexeme level.

At the conceptual level, the nodes represent concepts. Lexical concepts have direct connections to nodes at the second, lemma level. However, not all concepts are lexical (e.g., *dead tree* is a well-formed concept but it is one without a lexical concept; however, there is a lexical concept for *dead body* (corpse)). Lexical access in this model is represented by activation spreading from the conceptual level to the lemma level to the lexeme level. Bock & Levelt describe a procedure called 'indirect election' to explain activation of closed class elements not specified at the lemma level. According to Bock & Levelt (994, p. 952), the lemmas of open class words carry specifications about the closed class elements that can or must accompany them. For example, in *listen to the radio*, *to* does not represent a concept. Rather, the lemma for the transitive verb *listen* requires the preposition *to*, so *to* must be activated via an indirect route at the lemma level.

3.5.2.2 Function assignment

The primary problem of function assignment is to specify which elements will serve as the subject of the developing utterance and which, if any, will serve as objects of various kinds. The same words may serve different functions in different sentences (e.g., *Girls like boys* versus *Boys like girls*). This is a problem of grammatical encoding rather than of message formulation, because very similar messages may be expressed in ways that differ only in the assignments of grammatical functions (e.g., *She was handing him some broccoli* vs. *She was handing some broccoli to him*). The process of function assignment is heavily influenced by the content of a message (as is the selection of lemmas).

A problem with function assignment results in errors called phrase exchanges (e.g., *I went to a Thomas train for the toy world* instead of *I went to the toy world for a Thomas train*). Phrase exchange errors have two properties: a) those errors that are restricted to pronouns bear the appropriate case for the position in which they erroneously appear (e.g., *you must be too tight for them* instead of *they must be too tight for you*), and

b) the verbs in the error-bearing utterances tend to agree with the subject that is actually produced rather than with the subject that was intended (e.g. *that's supposed to hang onto you* instead of *you're supposed to hang onto that*) (p. 963).

3.5.2.3 Types of functions

Bock and Levelt used traditional case terminology to refer to the grammatical functions that are assigned (e.g., nominative, accusative, dative, genitive) and traditional grammatical relations terminology (subject, direct object etc.) to refer to where the elements that are assigned these functions actually appear in English sentences.

3.5.2.4 Information that controls function assignments

Two kinds of information that are presumed to be represented in the message control function assignment. They are:

1. Thematic[9] or event roles: The sets of thematic roles proposed in the literature vary widely (see chapter 2, section 2.3.3.3). Agents are often subjects, patients are often direct objects, and recipients are often indirect objects. One of the most important factors in the control of thematic/functional role assignment is the choice of the verb during lexical selection (p. 964).
2. Discourse or attentional roles: The correspondence between event roles and grammatical relations is made prominent through manipulation by discourse or conversational means. For example, when a person observes a scene in which a girl chases a boy and then is asked a question such as, *what happened to the girl or what happened to the boy,* then the questioned entity tends to be assigned the subject role in the answer (p. 965).

Bock and Levelt assume that these kinds of information are represented in the message, and that "their effects on the process of function assignment are in part mediated by the structural and semantic conventions of the speaker's language" (p. 964),

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[9] Thematic roles are also called event roles by some researchers (e.g., Marshall et al., 1993, Bock & Levelt, 1994).

importantly including the subcategorization conventions or argument structures of lemmas represented in the lexicon.

3.5.2.5 Nature and organisation of processes that carry out function assignments

"A verb's specification of its normally expressed arguments may serve to organise function assignment around a unit that is roughly equivalent to the clause" (Bock & Levelt, p. 966). In an experiment, Bock & Cutting (1992) induced verb agreement errors called attraction errors e.g., *customers* and *are* in *The only generalisation I would dare to make about our customers are that they are pierced.* The speakers were asked to convert complex subject phrases into full sentences by completing them. The phrases contained a head noun (e.g., *The claim*) followed either by a phrase postmodifier of the head (as in *The claim about the newborn babies was rejected*) or a clause postmodifier of the head (as in *The claim that wolves had raised the babies was rejected).* The critical fragments ended in a plural noun (*babies*) intended to elicit verb agreement errors in the completions. The question was whether the clause postmodifier would promote or retard this tendency relative to the phrase postmodifier. Bock & Cutting found that errors were more likely to occur after phrase than after clause post modifiers. This points to clauses as important organizing forces in functional processing (p. 967).

3.5.3 Positional level

Positional processing involves the creation of an ordered set of word slots (constituent assembly) and morphological slots (inflection). The processes taking place at this level are same as that in Garrett's model but the explanation for how the processes take place is different.

3.5.3.1 Constituent assembly

The output of the functional level consists of temporary linkages among stored elements and carries no basic order. Constituent assembly imposes a sequence on the elements of the utterance (p. 968).

3.5.3.2 Inflection

Bock & Levelt (1994) discuss the circumstances that lead to the selection of lemmas that require closed class elements. According to them, in some cases, the selection of affixes may be under the direct control of message elements, as when a verb is specified for past tense. But this connection becomes complex when there are syntactic dependencies among inflectional features. In English, agreement operates between the head of the subject noun phrase and the finite verb. According to Bock & Levelt, the processes responsible for the selection of appropriate affixes are set out within functional processing i.e., at the functional level.

Bock (1989) examined whether structural repetition (the tendency to repeat similar phrase structures across successive sentences) was dependent on the identity of closed class elements. She found equally strong structural repetition when the closed class members of sentences were different or the same. According to Bock, this suggests that forces that were different from the closed class elements controlled the phrasal configurations of sentences. This finding challenges Garrett's viewpoint according to which the elements of the closed class are intrinsic features of the grammatical frame.

3.5.4 Summary

Thus, Bock & Levelt (1994) expand on Garrett's model by providing details for the different steps that take place at each level. The features relevant to the current study are a) the selection of the lemma and the information activated by the lemma i.e., the semantic and syntactic features of a particular word, b) the selection of affixes for the past form of the verb and for the possessive form of the noun that can be under the influence of the message or can be retrieved as a part of the frame, and c) the construction of a sentence based on the intention of a person.

3.6 Levelt, Roelofs and Meyer (1999)

Levelt et al. (1999) outlined some special circumstances that are relevant for explaining different aspects of sentence production. Only aspects related to the current study are explained here.

3.6.1 Accessing morphologically complex words

The single-lemma-multiple-morpheme case. The word 'escorting' is generated from a single lemma *escort* that is marked for +progressive. It is only at the positional level that two nodes are involved, one for <escort> and the other one for <ing>. Regular inflections are probably all of this type, but irregular verb inflections are usually not. The lemma go+past will activate the one morpheme <went> (Levelt et al., 1999, p. 12).

3.6.2 The single-concept-multiple-lemma case

A verb such as *look up* is represented by two lemma nodes in Roelof's theory and computational model (Roelofs, 1998, cited in Levelt et al., 1999). In producing a verb-particle construction, the lexical concept selects for a pair of lemma nodes from memory and makes them available for syntactic encoding processes.

3.6.3 Singular- and plural-dominant nouns

In generating the plural of *nose*, the speaker first activates the lexical concepts *nose* and something like *multiple*. Together, they select for the one lemma *nose*, with diacritic feature *pl*. The lemma with its plural features then activates the two morpheme nodes <nose> and <ez>.

3.7 Current study

The existing models of sentence production vary in terms of their focus on different processes involved in sentence production such as grammatical encoding or phonological encoding. Additionally, the models vary in terms of the detail of the processes involved at a particular level (e.g., selection of affixes at the functional level). A consolidated model was used in the current study that combined selected concepts (relevant to the current study) elaborated by different researchers into one model to explain the processes involved in the selection of appropriate lexical concepts and the building of a syntactic framework (i.e., grammatical encoding) in normal speakers. This model will be referred to as the Grammatical Encoding Model (GEM) because it is a model that focuses mainly on the functional and positional level (i.e., on grammatical encoding) and does not explain the phonetic or articulatory processes involved in production of sentences.

3.7.1 What is GEM?

GEM is a combination of concepts selected from models of sentence production by Garrett (1984), Lapointe and Dell (1989), Bock and Levelt (1994) and Levelt et al. (1999). Selected concepts from these models appropriate to the language aspects focused on in the study (e.g., to teach the past affix for verbs and the possessive affix for nouns) were emphasised in GEM. GEM has five levels based on Garrett's model of speech production. The five levels are the message level, the functional level, the positional level, and the phonetic level and the articulatory level. GEM has the detail of Bock and Levelt (1994) in terms of the processes that take place at two main levels of the model (functional and positional). Lapointe & Dell's (1989) model provides information about the selection of affixes and the storage of affixes in GEM. Levelt et al. (1999) provide information about the difference between the retrieval of affixes for regular verbs and irregular verbs. The emphasis of the current study is only at the first three levels, namely, the message level, the functional level and the positional level; hence these three levels will be described in detail. The intervention in the current study will be based on GEM in order to test the validity of the model.

The assumptions made in Garrett's (1984) and Bock & Levelt's (1994) model hold for GEM too (see section 3.5). In terms of selection of verbs, these assumptions imply that the selection of a verb is going to be affected by the intention of the person (at message level) and the selection of a verb will affect the selection of arguments (at functional level) and retrieval of affixes associated with a particular verb (at positional level). Moreover, these assumptions imply that once a verb lemma is selected at the functional level, retrieval of affixes associated with that verb may be underway at the positional level at the same time.

3.7.1.1 Message level

The message representation has the information about *what* the person wants to say, *how* he wants to say it, *who/ what* it is about and also decisions about language specific information, like information about temporal relations. For example, if the person wants to say, *the woman asked the man a question*, then the message level will provide information that the person intends to talk about a *woman* who did a particular action (i.e., *ask*) in relation to a *man*. Also the message level will provide information that the woman has already completed the action (Garrett, 1984 and Levelt, 1989).

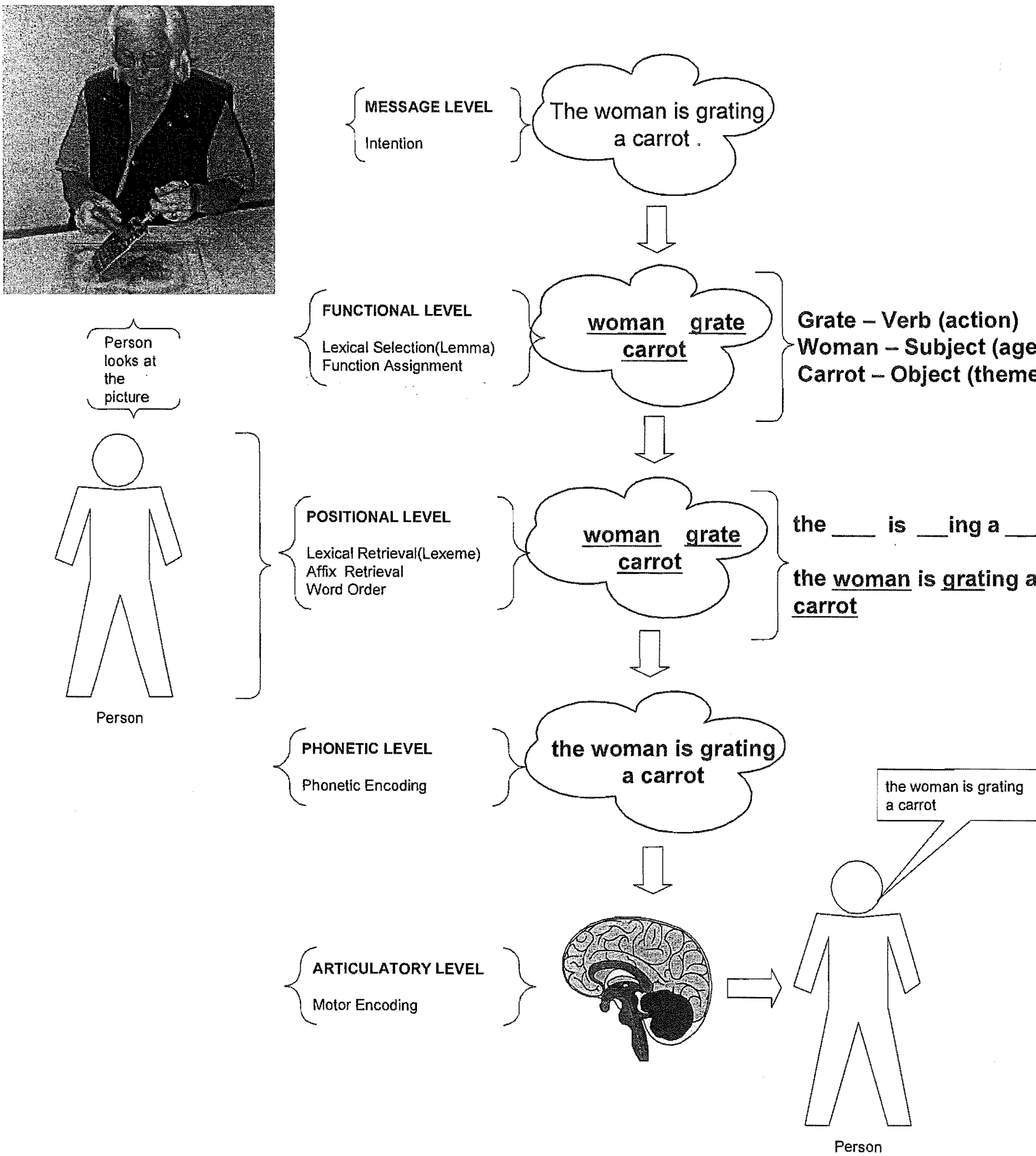
3.7.1.2 Functional level

There are two main steps that take place at the functional level: lexical selection and function assignment. Both the selection of lemmas and function assignment is heavily influenced by the message representation (Garrett, 1984 and Bock & Levelt. 1994). A flowchart of the model is presented in Figure 3.4.

Based on what the person wants to say, lexical selection will take place at the functional level. At the functional level, the meaning is retrieved without the word form and this nonphonological entity is called a lemma. The lemma retrieved at the functional level specifies the word's meaning, and its syntactic and morphological properties. The word form is not retrieved at this level. A verb lemma will provide information about the syntactic structure of the verb that is the information if the verb is an intransitive verb, monotransitive verb or a ditransitive verb (a verb that takes a direct and an indirect object). In the particular example (*the woman asked the man a question*), the lemmas retrieved without the word form will be *ask, woman, man* and *question*. The verb lemma will provide information that *ask* is an optional ditransitive verb. A noun lemma will provide information about the possible arguments that a noun can be. For example, in a sentence such as *the boy hit a ball, ball* cannot be the doer of the action. This specification of syntactic information of a noun helps the verb in choosing a particular noun as an argument based on the intention of the person.

The message elements that are mapped onto concepts and lemmas must also be assigned a syntactic function. Function assignment includes specification of the different types of functions and this specification is influenced by the message level representation. Types of functions include functional/thematic roles (e.g. agent, theme) and grammatical roles (e.g. subject, object), that is, the decision about who is the subject and who is the object, is made. The message level representation contains information about thematic roles and attentional roles that will result in function assignment at the functional level. The choice of the verb will affect the thematic roles and attentional roles will emphasise the focus of the discourse that will affect the selection of the subject. For example, the selection of a particular verb will specify the grammatical structure of that verb – *chop* is a verb that requires someone doing the chopping and something that is being chopped. Thus in this case the thematic roles assigned will be the *agent* and the *theme*. Attentional roles will change the focus of the discourse by making the questioned entity the focus of the discourse. For example, if there is a picture that involves two people engaged in an

Figure 3.4 The grammatical encoding model (GEM) of sentence production Garrett (1984), Bock & Levelt (1994), Levelt (1999)



activity, a question such as *what is the woman doing* can change the focus of the conversation or discourse.

In the particular example, the agent (subject) will be *woman*, the theme (direct object) will be *question* and the patient (indirect object) will be *man*. A lemma will also provide information about the affix that will attach to the verb or the noun. Based on the message, the presence or absence of the affix is specified at the functional level resulting in retrieval of the phonological form at positional level. Similarly, the function words will be retrieved at the positional level based on the specification by the lemma or the message. The noun lemma will provide information about the elements of the noun phrase, for example, the noun phrase would consist of a determiner and a noun (e.g., *the cow*).

3.7.1.3 Positional level

The two main processes taking place at the positional level are a) constituent assembly and b) inflection. Constituent assembly imposes a sequence on the elements of the utterance (Bock & Levelt, 1994). Inflection involves the selection of affixes and function words. At the positional level, the word order of the utterance will be specified and the word forms of the lexical concepts that were activated at the functional level will be retrieved. In addition, the inflectional affixes and the function words associated with the verb and the nouns are retrieved at this level.

In the current study, two inflectional affixes, a verb affix *-ed* and a noun affix *'s* are the target affixes to be trained in the affix module of intervention. The selection of these affixes would be under the direct control of the message elements as proposed by Bock and Levelt (1994). This would result in the retrieval of these affixes in the sentence frame at the positional level. The inflectional affixes are stored separately from the lexical stems in a store that we will call notion stores (based on Lapointe & Dell, 1989). The notion stores consist of the semantic notions associated with inflections. Thus, the past inflectional affix along with the other affixes for verbs (e.g., *-ing, -en*) would be contained in a verb phrase (VP) notion store and the possessive inflectional affix along with other affixes (e.g., plural *-s*) in a noun phrase (NP) notion store. As the selection of these affixes is directly under the control of the message, these inflectional affixes would be retrieved in the planning frame at the positional level based on the message. Retrieval of the past affix for the verb is further differentiated in terms of the regularity of the verb. Regular verbs would fall into the single-lemma-multiple-morpheme case as explained by Levelt et al. (1999, see section 3.6). For regular verbs (e.g., *asked*), the past affix specified by the message will result in the generation of a single lemma that is marked for +past and two morphemes will be activated i.e., the lexical stem (*ask-*) and the past affix (*-ed*). The lemma of the lexical stem will be retrieved at the functional level but the affix will be retrieved at the positional level in the form of the planning frame. In the case of irregular verbs (e.g., *chose*), the message will activate the lemma *choose* + past that will activate the one morpheme *chose.*

3.7.1.4 Phonetic & Articulatory

Once the word form is retrieved at the positional level, this information will go to the phonetic level for phonetic encoding which will then go on to the articulatory level for motor encoding resulting in activation of articulatory processes and the speech muscles to be articulated.

3.7.1.5 Summary

The main points of GEM are:

a) Information flow is from top to bottom, in sequence i.e., from message level to functional level to positional level to phonetic level and to articulatory level. A basic premise is that language production is *incremental*, where incremental means that the higher levels need not complete their work on an utterance before the next level begins.

b) A lemma of a particular lexical concept retrieved at the functional level specifies the grammatical class and the set of diacritics associated with that grammatical class. For example, the lemma of a verb (e.g. *ask*) will activate the argument structure of the verb (i.e. subject, direct object, indirect object) and will specify the diacritics associated with that verb (e.g. tense and aspect).

c) The inflectional affixes and function words are specified by the message and the lemmas retrieved at the functional level. The message level would indicate which of the specific diacritics for that particular grammatical class would be chosen. The relevant inflectional affixes and function words are retrieved separately from the lexical stem (e.g. *-ed* from *ask*) at the positional level.

d) At the positional level, the phonological word forms of lemmas (i.e., lexemes) are retrieved and word order is imposed.

Chapter 4 will discuss the application of models of sentence production in aphasiology to explore the relationship between lexical retrieval and sentence production. In order to apply a model of normal sentence production to aphasiology, the model should be able to explain the types of symptoms seen in patients with aphasia (Saffran et al, 1980b).

4 Chapter Four: Application of models of sentence production to aphasia

4.1 Introduction

Researchers have applied various models of sentence production to explain the different symptoms seen in patients with aphasia (e.g., Saffran et al, 1980b; Schwartz, 1987, and Garrett, 1992).

The section below describes how GEM explains the various symptoms seen in patients with aphasia. The different symptoms explained by the models will be categorised into lexical retrieval symptoms and sentence production symptoms. The section on sentence production will include both morphological and syntactic symptoms. Each section will explain the symptoms seen in patients with aphasia followed by an explanation of the possible impairment level within GEM. The description of impairment levels will be followed by studies that have focused on that particular aspect. These sections will be followed by a section that will explore the studies focusing on lexical retrieval and sentence production.

4.2 Lexical retrieval

Lexical retrieval difficulties that are seen in patients with aphasia result in an inability to produce certain nouns or verbs during communication. Difficulties in retrieving and producing particular words that a person needs to express oneself, are present in the majority of people who have had aphasia and are referred to by the name of *anomia*.

The types of difficulties range from an inability to produce a lexical target in a sentence to paraphasias. A paraphasia is a "language-production error involving substitution or replacement" (Brown, 1972). Errors observed in the production of a lexical target in a sentence include semantic and phonological errors.

Semantic errors: Semantic errors are word substitutions that are semantically related to the target word e.g. *flower/plant* (Garrett, 1992, p. 147). Garrett identifies two general loci of potential failure that could give rise to semantic errors: conceptual impairment and various aspects of lemma processing (i.e. conceptual to lemma mapping, lemma representation failure, and lemma to form mapping) (Garrett, 1992). Word-form output system failure (Caramazza and Hillis, 1991) has also been noted as one of the probable loci. A word-form output failure could result in semantic errors in one modality and not another, for example, oral but not written production (as in HW) or vice versa (as in SJD) (Caramazza and Hillis, 1991). According to the dual lexical retrieval process (Garrett, 1984), the first step involves retrieval of a lemma and the second step involves retrieval of a lexeme (word form) for a particular lexical item. The dual lexical retrieval process is the same as that described in GEM. During lemma retrieval, when the semantic specification fails to yield a correct match between lemma and lexeme, the result is a word error unrelated to the target (in those cases where selection has been totally unconstrained, e.g., *dime* for *get*), or a response semantically related to the target (where selection has been imperfectly constrained, e.g., *girl* for *boy*).

Phonological errors: Responses that are phonologically related to the target (phonemic paraphasias) (e.g., *noy* for *boy*) occur in response to a breakdown in the mechanism that selects and orders phonological segments at the point when content words have been retrieved and are being placed into phrasal frames (Buckingham, 1986, p. 200).

A majority of these error types are common to both verbs and nouns. Verb errors reported in the literature include phonemic paraphasias (e.g., *tusting* for *dusting,* Breedin, Saffran and Schwartz, 1998), semantic paraphasias (e.g., *goin* interpreted as *going* for *doing,* Schwartz, 1987; *ride* for *run*, Buckingham, 1981) and light verbs such as *have, come, do,* and *get* etc. used instead of more appropriate heavy verbs (e.g., Berndt et al., 1997a). For example, one of the participants' in the current study produced a light verb in place of the main verb when she was unable to produce the target verb (e.g., *she did it*, target sentence: *she chopped the pepper*). Patients with impaired noun retrieval and normal phrasal construction have impaired lexeme retrieval (Garrett, 1992). Patients with problems in verb retrieval only with normal phrasal construction would have impairment at the same level i.e., lexeme retrieval at the positional level.

4.2.1 Factors affecting lexical retrieval

Researchers have shown that object recognition and naming in patients with aphasia are influenced to varying degrees by such factors as homomorphy (shape similarity), familiarity, value to perceiver, manipulability, characteristic motion, characteristic sensory modality of transaction (vision, touch, hearing), frequency, imageability, concreteness, length, operativity and the visual complexity of the stimulus picture and typical age of acquisition (e.g., Tranel et al., 1997; Nickels and Howard, 1995). Nickels and Howard (1995) found that the two groups of patients in their study showed different patterns of variables affecting their naming performance (p. 1295). The authors suggest that "the differences between the patterns observed reflect differences both between the stimuli and the patients" (p. 1295).

Similarly, different kinds of factors affect verb retrieval. The kinds of factors that affect verb retrieval range from factors related to semantic complexity of verbs to factors such as the elicitation context of that particular verb. Table 4.1 describes the different factors identified in the literature in patients with aphasia.

In the current study, the factors controlled include frequency of occurrence, homophony, imageability and the argument structure of verbs. These factors will be discussed in detail.

4.2.1.1 Frequency of occurrence

Studies indicate that frequency of occurrence may and may not affect the retrieval of nouns and verbs in patients with aphasia. Results from Kemmerer and Tranel (2000), Berndt et al. (1997a) and Breedin et al. (1998) indicate that frequency of occurrence can interact with other factors (e.g., semantic complexity) and show an effect on verb retrieval patterns, but frequency of occurrence in isolation does not show any particular pattern. Patients were more likely to retrieve target verbs that incorporated a greater number of semantic features i.e., verbs that were semantically complex (Breedin et al., 1998). Berndt et al. (1997a) and Jonkers & Bastiaanse (1998) found no effect for word frequency for patients with aphasia. Some levels of impairment may be expected to result in a frequency effect while others may not. The presence or absence of a frequency effect could be attributed to a difference in the level of impairment in different participants (Nickels & Howard, 1995). In addition, the variable effect of frequency could be

Table 4.1 Factors affecting verb retrieval in patients with aphasia.

Factor	**Findings/effect**	**Researcher**
Frequency of occurrence	Negative frequency effect[1] Variable effect	Breedin et al. (1998) Kemmerer et al. (2000)
Semantic factors	Addition of semantic features can facilitate verb retrieval	Breedin et al. (1998)
Homophony	Verbs with homophonous nouns are easier to retrieve	Kemmerer and Tranel (2000)
Familiarity	Familiar verbs are easier to retrieve	Breedin and Martin (1996)
Imageability	Higher imageability can help in lexical retrieval	Berndt et al. (1997a) Bird et al. (2000)
Elicitation context	Affects accuracy of verb retrieval	Berndt & Haendiges (2000)
Argument structure	Affects verb retrieval and the processing of sentences	Shapiro et al. (1993)
Instrumentality	Instrumental verbs easier to retrieve	Bastiaanse (1991)
Image agreement	Performance poor for verbs with low image agreement	Kemmerer & Tranel (2000)

attributed to the fact that the frequency of occurrence values used in all the studies are actually computed from written materials rather than naturally occurring spoken language (Kemmerer and Tranel, 2000).

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[1] Six of their eight patients showed a negative frequency effect, that is, they were more likely to retrieve low frequency verbs than high frequency verbs. Breedin et al. consider this negative frequency effect to be an artifact of semantic complexity.

4.2.1.2 Homophony

Homophony refers to verbs that have an identically similar sounding noun (e.g., *kiss, race*). Jonkers & Bastiaanse (1996) found that a verb such as *to saw* (that is name related to the noun *saw*) was easier to retrieve than a verb that was not related in name to a noun (e.g., *sew*) in patients with Broca's aphasia. Similarly, Kemmerer & Tranel (2000) found that the subjects with brain damage were significantly better at retrieving verbs with homophonous nouns (e.g., *cut, mail, sail*) than verbs without homophonous nouns (Kemmerer & Tranel, 2000, p.371). Berndt et al. (1997a) called this feature *grammatical class ambiguity.* Homophony is likely to have an effect on sentence production too because a particular word would activate the features of a noun and a verb. For example, a word such as *cut* would activate the verb *cut* with the appropriate syntactic structure (i.e., an intransitive or a ditransitive verb) and the noun *cut* (e.g., *the boy had a deep cut*). Homophony would help in retrieval of the particular word in the sentence but the usage of the word as a noun or a verb may depend on the participant's ability to retrieve nouns and verbs (Berndt et al., 1997b).

4.2.1.3 Imageability

The term imageability has been used in the literature in two different ways: a) the ability to picture the action (e.g., Berndt et al., 1997 a) and b) the total number of features present in the semantic representation of a word (Bird et al., 2000). A difference in the imageability ratings of verbs and nouns used in a study can result in a grammatical class difference. For example, Berndt et al. (1997a) found that four of the nine patients with aphasia could distinguish nouns from verbs when the words were imageable (e.g., *fill, hang*), only two of these patients continued to do so when the words were abstract (e.g., *deny, fail*). Bird et al. (2000) found that patients performed with similar accuracy for nouns and verbs when imageability was controlled across word classes. According to Bird et al., controlling for imageability is not possible in picture naming "but is possible for other tasks, such as reading, writing, repetition, lexical decision and synonym judgments" (p. 221).

4.2.1.4 Argument structure

Argument structure has been a topic of research in both comprehension and production of verbs[2]. Sentence comprehension studies show that argument structure affects the processing of sentences in normal and in persons with Broca's aphasia (e.g., Shapiro & Levine, 1990; Shapiro et al., 1993). In contrast, fluent aphasic speakers were found to be not sensitive to the argument structure information represented with verbs (Shapiro & Levine, 1990). Sentence production studies indicate that verb activation difficulty increased with an increase in the number of arguments and/or the number of participant roles (thematic roles) of the verb (e.g., Thompson et al., 1994, Thompson et al., 1997a, Kim & Thompson, 2000).

Shapiro, Gordon, Hack & Killackey (1993) explored the real-time access of verb-argument structures in three groups, namely, normal controls, persons with Wernicke's and Broca's aphasia, with the help of a Cross Modal Lexical Decision (CMLD) task. In a CMLD task, the subjects are required to listen to sentences for meaning (presented through headphones) and to make a lexical decision (word/nonword) on an unrelated probe visually presented in the immediate temporal vicinity of the verb. It is assumed that the CMLD, when presented immediately after the verb, reflects local sentence processing load in the immediate vicinity of the verb. Specifically, Shapiro et al. examined whether their subjects exhaustively access the thematic representations of verbs in active, passive, subject-cleft[3] and object-cleft[4] sentences. They found that normal speakers and person with Broca's aphasia were sensitive to the thematic properties of verbs, regardless of sentence type. According to the researchers, the results imply that the real-time process of accessing a verb and its thematic properties is independent from the difficulties these patients have with comprehending complex sentences because patients with Broca's aphasia showed a normal time course of verb-argument structure activation in such sentences (p. 441).

In the study by Thompson et al. (1997a), the authors examined aphasic and non-brain-damaged subjects' production of six verb types (with verb type based on argument

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[2] For information on verbs and verb arguments, please refer to chapter 2, section 2.3.3

[3] For example, *It was Joelle who hit Dillon last night.*

[4] For example, *It was Dillon who Joelle hit last night.* Described as *cleft-object* in the article.

structure characteristics) in order to examine the influence of the argument structure characteristics of verbs on verb retrieval. Verb production was examined and compared in two conditions; a confrontation naming condition in which pictured verbs were presented for subjects to name, and an elicited naming condition in which story-completion cues were provided to facilitate production of target verbs. Verbs with fewer and less complex argument structures appeared to be easier for agrammatic aphasic subjects to produce – even when produced as single words (similar to the findings of Thompson et al., 1994, p. 485). Thompson et al. suggested that verb activation processes, like noun activation processes, involve searches through the lexicon – a lexicon that for a verb includes not only information about its lexical category and phonological form, but also information about its argument structure characteristics. Therefore, an increase in the number of arguments increased verb activation difficulty (p. 485).

The view that argument structure affects the production of verbs is also supported by Bastiaanse and Jonkers (1998) who found that verbs without internal arguments[5](same as one-place verbs) are produced most often, followed by verbs with one internal argument (i.e., two-place), whereas verbs with two internal arguments or a clausal argument are produced considerably less often. This pattern seen in agrammatics was similar to that seen in normal controls and anomic aphasic individuals indicating similar patterns in patients with predominant noun retrieval problems. In contrast, Jonkers and Bastiaanse (1996) found that (pseudo) transitive verbs (i.e., those verbs that (may) take an object or verbs that can be both one-place and two-place) are easier to retrieve than intransitive verbs (i.e., one-place verbs).

Summary: These studies indicate that a number of factors can influence noun retrieval and verb retrieval. Because of the differential effect of these factors, researchers need to control for all these factors to obtain valid results in terms of grammatical class differences. In addition, individual differences may be seen in response to a particular factor. Despite the awareness of the effect of the factors affecting lexical retrieval, it may not be possible to control for all these factors dependent upon the research question of a

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[5] The argument(s) of a predicate realised inside the phrase that contains that predicate (e.g., inside the verb phrase if the predicate is a verb) is called an internal argument, for example, in *John gave a book to Tom*, *book* and *Tom* are internal arguments of the verb *give*.

particular project. For example, if argument structure is one of the factors crucial to a project, it is difficult to control for frequency of occurrence too because the verbs falling into different categories of argument structure (e.g., ditransitive) are limited. Therefore, the results of such studies should be interpreted bearing in mind the factors that were not controlled for.

4.2.2 Verbs and nouns

A syntactic category deficit is a loss of capacity to produce items from open class vocabulary. Verbs and nouns belong to two different grammatical categories. Patients with aphasia have shown different patterns of performance in relation to these categories. The differences and similarities in the performance patterns in relation to these categories are discussed in this section.

4.2.2.1 How do verbs compare with nouns?

Differential patterns of dissociations in comprehension and production of verbs and nouns in several aphasic patients have been reported (e.g., Saffran, Schwartz & Marin, 1980a; Miceli, Silveri, Nocentini & Caramazza, 1984, 1988; Zingeser and Berndt, 1990). Those patients who had difficulty naming verbs had a tendency to nominalize the expected action name (e.g., in *shirt washing done, washing* indicates gerundive instead of progressive*; the work* instead of *to work*). In contrast, patients who had difficulty naming nouns were more likely to make omission errors (i.e., did not produce the target noun).

The notion that nouns are retrieved differently from verbs is supported by neurological evidence from Damasio and Tranel (1993). According to Damasio & Tranel, the systems that mediate access to concrete nouns are anatomically close to systems that support concepts for concrete entities. Their findings also suggest that systems that mediate access to verbs are located elsewhere and are anatomically close to those that support concepts of movement and relationship in space-time (p. 4960).

4.2.2.2 Is there an association between the selective impairment or preservation of verbs and aphasia type and/or the locus of the lesion?

In a comparison of five moderately severe Broca's and Wernicke's subjects with five normal speakers, Gleason, Goodglass, Obler, Green, Hyde & Weintraub (1980) found that Broca's aphasia subjects were noun users and Wernicke's aphasia subjects were verb users. Agrammatism has been linked to problems in action naming and anomia to problems in object naming (e.g., Miceli et al., 1984; Zingeser & Berndt, 1990 and Jonkers & Bastiaanse, 1996). On the contrary, Basso et al. (1990b) found no significant differences between action and object naming for patients with agrammatism or for anomia. Berndt et al. (1997a) had one subject with classical agrammatism who showed no difference between verbs and nouns. Bastiaanse & Jonkers (1998) found that both agrammatics and anomics were more significantly impaired in action naming than in object naming. These studies highlight the individual differences within and between patients and syndromes. Therefore, though impaired verb retrieval has been found to be associated with agrammatism, it is not necessarily a feature of agrammatism only.

4.2.2.3 At which level of the word processing model are verb/noun differences to be located?

Verb/noun differences could arise at the conceptual level. The symptoms at the conceptual level would include difficulty interpreting pictured actions (Berndt et al., 1997a). At the lexical level, verb/noun differences can occur at the level where semantic and syntactic features of a lexical item are activated (the lemma level) or at an output level (phonological or orthographic output lexicon).

Retrieval impairments that are selective for grammatical class would likely be attributed to failure at the lemma level of lexical representation, since grammatical class information is argued to be represented at that level (Bock & Levelt, 1994). Production of verbs or nouns in isolation is not necessarily related to a difficulty in comprehension of these grammatical classes. For example, in Berndt et al. (1997a), two separate aspects of comprehension were tested: appreciation of the grammatical class (and semantic category) distinction[6] between verb and nouns (action and object names) and comprehension of subtle distinctions in meaning[7] within the classes of nouns and verbs.

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[6] For example, each word was printed on a card and the patients were asked to sort the cards into two stacks to represent verbs (also cued with actions, things you do) and nouns (persons, places or things). Each word was read aloud to the patient as the card was presented for sorting, e.g., *'eat', 'bird'*.

[7] For example, in the photo matching task, black and white photographs were produced for each action and object and their distractors. Patients were asked to point to the photograph that best depicted the spoken stimulus word, e.g., *eat* (distractor *drink*), *shoe* (distractor *boot*).

Several of the patients with selective verb production impairment were able to appreciate grammatical class (i.e., sort the cards into verbs and nouns), indicating that their frequent substitution of nouns for verbs when naming actions did not arise from a basic lack of understanding of grammatical class distinctions (p. 93).

Kim and Thompson (2000) used Bock & Levelt's model to explain the different loci of impairment in patients with poor verb retrieval. They presented tasks requiring comprehension (grammaticality judgment task and comprehension) and production (naming) of nouns and verbs to seven agrammatic aphasic patients to study the relationship between verb retrieval and verb-argument-structure properties. In their subjects, Kim and Thompson found a selective deficit in the production of verbs as compared to nouns in the confrontation naming condition. Performance on both noun and verb comprehension was good. Moreover, verb production was influenced by verb type i.e., the number of arguments influenced verb production. Noun categorization was intact while verb categorization was impaired. The subjects showed normal performance on a grammaticality judgment task. According to Kim and Thompson, these performance patterns on the different tasks imply that the locus of impairment was in accessing the lemma level of representation for production (p. 15).

According to Kim and Thompson, the near-normal performance on the comprehension and the grammaticality judgment tasks indicated intact representation of the verb's lexical-syntactic entry (i.e., verb lemma), but the impaired production on verb categorization and verb production in the confrontation naming task implicated disrupted access to the lemma level of representation for output tasks including verb production and categorization (p. 15). According to them, a failure at the level of lemma selection would affect the availability of information concerning the syntactic properties of the verb such as its subcategorisation frame (see chapter 2, section 2.3.3.2). A failure at the lexeme level would result in production of utterances with NPs representing argument structure in the absence of the target verb. Only verbs will be affected in these patients because they have a selective verb retrieval deficit.

Caramazza and Hillis (1991) contradict Bock and Levelt (1994) by locating selective grammatical class effects not at the lemma level, but in the word form (the output lexicon). They reported two brain-damaged subjects with modality-specific deficits restricted to verbs in oral and written production. H.W. made semantic errors only in reading and in the oral naming task while S.J.D. made errors only in writing and in the written naming task. The two patients produced semantic errors only in one modality of output (speaking or writing), irrespective of whether the input was a word or a picture, and both patients showed normal comprehension of single words – these findings suggest that the locus of functional deficit is at a level where lexical phonological representations (for HW) and lexical orthographic representations (for SJD) are specified for output i.e. the phonological output lexicon and the orthographic output lexicon (p. 789). The output lexicons refer to the positional level in GEM.

To summarise, verbs and nouns can be differentially affected in people with aphasia. Poor verb retrieval or noun retrieval is not a feature of a particular type of aphasia. A difference in the response to verbs and nouns can be a result of the different brain regions responsible for producing them (e.g., Damasio & Tranel, 1993) or to individual differences within and between patients and syndromes.

4.2.3 Lexical retrieval – Model based therapy studies

This section deals with noun retrieval and verb retrieval. Although the focus here is on model-based therapy studies, the following section will describe the main therapy approaches used in the literature briefly followed by model-based therapy studies. An enormous number of studies exist in the clinical aphasiology literature in relation to noun retrieval but the aim is not to review all the studies here. Rather, the aim is to mention briefly the main therapy approaches that have been used to improve noun retrieval.

4.2.3.1 Noun retrieval

Therapeutic procedures that have been used to help with noun retrieval include either 'semantic' or 'phonological' techniques. Some researchers use a combination of them (Nickels & Best, 1996a, p. 28). Examples of **semantic therapy** techniques include tasks such as a) pointing to the picture from a set of four semantically related pictures on spoken request (auditory word-picture matching) and b) spoken word-picture verification i.e., presentation of a picture along with a spoken word and asking the patient to verify if the spoken word matches the picture or not (Nickels & Best, 1996a, p. 30). Most of the tasks do not require the patient to say the picture name. Examples of the **phonological** techniques include a) repeating the picture name (e.g., Zingeser & Berndt, 1988); b) attempting to produce the name with the aid of a phonemic cue (e.g., Breen & Warrington, 1994); and c) judging whether the name rhymes with another word (e.g., Raymer et al., 1993). Other procedures used include cueing hierarchies and semantic feature analysis (Bollinger & Stout, 1976; Linebaugh & Lehner, 1979; Boyle and Coelho, 1995).

Four different studies (Hillis, 1991; Raymer et al, 1993; Hillis and Caramazza, 1994; and Nickels and Best, 1996) related to noun retrieval are described briefly to indicate the ways in which a model can help in providing a rationale for treatment (see Table 4.2). The therapy techniques used were semantic, phonological or a combination of both. Therapy focusing on semantic tasks[8] uses the information at the functional level in the form of lemmas, phonological tasks use information at the positional level in the form of lexemes and a combination of the two uses information at both the functional and the positional level. Models are used to drive therapy (Hillis, 1991) and to identify the point of emphasis in a particular client (Raymer et al., 1993). However, identification of a locus of impairment does not necessarily predict the treatment effect (e.g., Hillis & Caramazza, 1994; Nickels & Best, 1996b).

These studies indicate that it is helpful to identify the level of impairment in a model but difficult to predict if a particular patient will benefit from the treatment suggested by the model. Reasons for the uncertainty include the lack of detail in the models of normal cognitive function on which the therapy is based and unidentified factors that should be present or absent in an individual for the therapy technique to be successful (Best and Nickels, 2000). According to Hillis and Caramazza (1994), in order to be able to predict the success of a particular treatment approach with a patient, more information is required. First, a theory of cognitive mechanisms that explains language performance in individuals with brain damage is needed. Second, a theory of normal

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[8] Semantic tasks include function judgment (i.e., this task involved the use of *yes/no* questions that specifically concerned the function of an object e.g., *Do you eat an apple?)* and relatedness judgment (i.e., the subject was provided with a picture or written word, and was required to decide whether or not it was related to a number of other pictures or written words) (Nickels and Best, 1996b).

Table 4.2 Examples of model based therapy studies for impaired noun retrieval in patients with aphasia. POL (phonological output lexicon), POC (phonology-to-orthography conversion), OPC (Orthography-to-phonology conversion).

Researcher	Participants	Therapy procedure	Findings
Hillis (1991) shows how models can drive therapy based on locus of impairment	22 yr old woman with failure at the lexical-semantic system and POL	Teach semantic distinctions with a subsequent phonemic treatment	Improvement in semantic tasks. Improvement in oral reading and naming
Raymer et al. (1993) show that the model provides information to focus on accessing phonological representations from semantics but does not inform how to do it	Four. Lexical-semantic information failed to access phonological representations. Impairment at the functional level.	Improve access from semantics to phonological representations using naming and providing cues (rhymed word, phonemic cue)	All four subjects improved in oral naming. Generalisation to naming of untrained items seen in three subjects.
Hillis & Caramazza (1994) - Contrasting treatment approaches can be equally appropriate with respect to a given locus of impairment	Three participants with semantic errors in naming and different loci of impairment.	Teaching POC rules and OPC rules; cueing hierarchy, word-picture matching	Procedure not effective for one participant but was effective for another. One strategy appropriate for different levels of impairment.
Nickels & Best (1996b) show that treatment effect may not correlate with the predictions from assessment results	Three patients with semantic deficits	Semantic therapy such as function judgment, relatedness judgment and word-to-picture matching	The same task may be differentially effective across patients

cognition must be capable of explaining how a damaged system may be affected by specific therapeutic procedures. Third, there is a need for identification of factors that influence the potential for recovery. Fourth, a method to identify what constitutes the same impairment in different patients is needed (p. 453).

4.2.3.2 Verb retrieval

Model-based intervention studies focusing on verb retrieval are summarised briefly in Table 4.3. The study by Fink and her colleagues (Fink et al., 1992) on Direct Verb Training (DVT) and Verb priming showed that DVT was more successful than Verb priming in improving verb retrieval. The success of DVT is self-explanatory because DVT not only includes activation of the word form but also includes describing the action, reporting the agent and theme and then composing a sentence, i.e., DVT activates all the levels of a model of sentence production. As a result, DVT was a more effective training procedure than verb priming that focuses on the phonological aspect tapping into the positional level only. In addition, the study by Fink et al (1997) uses an exposure task that was found to be as effective as multimodality intervention. However, the exposure task involves a semantic verification task with an additional corrective feedback and one opportunity to practice the phonological word form of the verb. Thus, the exposure task used in Fink et al.'s study already corresponds to a combination of a semantic and a phonological task with corrective feedback that is sufficient information for retrieving a verb.

4.3 Sentence production

Sentence production symptoms seen in patients with aphasia may have features of agrammatism or paragrammatism. Linguistically, sentences may be affected in terms of syntax, morphology or both.

Agrammatism: Traditionally, agrammatism is a part of the larger syndrome of Broca's aphasia (Goodglass, Quadfasel & Timberlake, 1964). Agrammatism is the loss of or disturbance in the use of those linguistic devices that in a general way serve to grammaticize speech (Pick, 1931/1994, p. 268). These linguistic devices include the auxiliary words and inflectional devices. Features noted in speech production include

Table 4.3. Model-based therapy studies focusing on verb retrieval in patients with aphasia.

Researcher	Participants	Therapy procedure	Findings
Fink et al. (1992) developed two different approaches to improve verb retrieval in the context of sentence production	1 patient with aphasia (9 years post CVA)	Direct verb training (DVT) and verb priming. DVT included name, the information about arguments and composition of a sentence. Verb priming was repetition	DVT yielded facilitation of access to that verb but did not generalise to other verbs. Verb priming was a short term facilitator.
Fink et al. (1997) show that extra information is not always more beneficial than the basic information.	Five patients with aphasia: two were characterised as nonfluent nonagrammatic while the remaining three were nonfluent with varying degrees of agrammatism	5 verbs were trained and exposed. 5 verbs were exposed only. A sentence assembly/verb-probe procedure[9] was used. Exposure included a comprehension task followed by corrective feedback and naming the picture.	Marked improvement for both trained and exposed verbs but not control verbs. A follow-up study showed the exposure manipulation would produce equally strong gains as the verb probe procedure.

[9] For example, *Examiner: Someone carried the sofa. It was the mover. Did I say the mover dropped the sofa?*

Subject: No, he (the mover) carried the sofa.

impaired verb retrieval for both single word production (McCarthy & Warrington, 1985) and sentence production (Saffran, Schwartz & Marin, 1980b) and a mapping deficit in sentence production. In a mapping deficit, impaired mapping between grammatical constituents (subject, object) and thematic roles (agent, theme) has been noted (Schwartz, Saffran, Fink, Myers & Martin, 1994). In other words, patients are not able to interpret the assignment of thematic roles. For example, the participants are not able to identify the agent in non-canonical[10] sentences (e.g., *the boy was hit by the ball).*

Paragrammatism: Paragrammatism is associated with the syndrome of Wernicke's aphasia, also referred to as fluent aphasia (Goodglass and Kaplan 1972). Paragrammatism is characterised, in pure cases, by disturbances in the use of auxiliary words, incorrect word inflections, and erroneous prefixes and suffixes (Pick, 1931/1994, p. 269). Paragrammatism presents "confused and erroneous syntax and morphology instead of an absence of grammatical structure" (Butterworth & Howard, 1987, p. 2). Errors seen in patients with paragrammatism are divided into five categories: open class lexical errors (e.g., *and I want everything to be so talk*), closed class lexical errors (e.g., I was fed up *to* all of them), inflectional errors (e.g., *right, and I wented with…*), constructional errors (e.g., *I'm very want it*) and residue (e.g., *they were snake…they were lodged, lodged rose in bin*) (Butterworth & Howard, 1987).

Features of syntactic deficits: Syntactically, constituent structures are simplified. For example, verb phrases may contain direct objects, but direct-indirect or direct object-prepositional phrase combinations are rare, and noun and adjective modifiers are rarely present in the noun phrases (Schwartz et al., 1995, p. 101). Sentences with ungrammatical sentence structure e.g., *now, I've own the sun would quiet* (e.g., Buckingham and Kertesz, 1974) may be seen. Patients may not omit grammatical morphemes but may have inflectional variants (e.g., in response to a picture of *a girl giving flowers to her teacher;* the patient says: *girl…wants to…flowers…flowers and wants to…*) (Saffran et al., 1980 a).

[10] Sentences that do not follow the order of subject-verb-object (SVO).

Features of morphological deficits: Morphologically, bound morphemes (i.e. verb and noun inflection) and function words are largely absent from the speech of patients with features of agrammatism.

In clinical descriptions of the spontaneous speech of English-speaking agrammatics, main verbs are typically produced in one of two forms: (a) the uninflected form (e.g. *walk*), and (b) the verb + ing (e.g. *walking*) (Goodglass, 1968). An example of agrammatic speech production (taken from Schwartz 1987, p. 169) elicited by picture description (a girl presenting flowers to her teacher) is as follows:

'The girl is…going to flowers'

The girl is flower the woman'

Mapping: Mapping is the ability to relate *who did what to whom* by correlating the grammatical roles with the functional roles, for example, correlating subject with agent. A problem in function assignment results in an inability to relate the grammatical roles with the functional roles and is called a mapping deficit. The symptoms of a mapping disorder include reversal errors in comprehension and reduced production of verb argument structure (Marshall, 1995). Two types of mapping deficit have been identified (Schwartz et al., 1987, 1994): a lexical mapping impairment and a procedural impairment. Subjects with a lexical impairment have impoverished verb entries that fail to supply thematic information. The verb's semantic information dictates the type of event occurring, the number of entities involved and their role in the event (i.e., their thematic role) (Marshall, 1995, p. 519). In the procedural mapping impairment lexical information is retained but procedures by which roles are assigned to moved argument structures are lost. The symptoms that result from procedural mapping impairment are preserved comprehension of canonical structures but affected comprehension of non-canonical structures as the assignment of the verb's thematic roles to these structures is no longer projected directly from the verb, but is dictated by general rules (or procedures).

Explanation of symptoms by GEM: A particular symptom may not be a result of one particular level or process but may involve a combination of processes or levels. Symptoms seen in patients will be discussed in relation to the different levels of GEM:

Message: An impairment at the message level in the form of simplified messages results in telegraphic speech (e.g., Bastiaanse, 1995).

Functional: A lemma at the functional level specifies the semantic and syntactic features of a lexical item. A successful retrieval of the lemma of a verb should be able to help in the correct specification of the subcategorisation frame of that verb. The subcategorisation frame retrieval in turn should help in sentence production provided the processes at the positional level, phonetic and articulatory level are not affected. Thus, a lemma retrieval disorder may affect the semantics and the syntax. The semantic aspect may affect comprehension of the patient and result in semantic errors in production (i.e., lexical retrieval). Incorrect selection of lexical items can result in an incorrect subcategorisation frame resulting in sentences with unusual argument structures (e.g., Schwartz, 1987, p. 188). An impaired verb lemma may not activate all the arguments of a verb resulting in grammatically incomplete sentences (e.g., *man ask woman, woman wipe*). After function role assignment, a lack of mapping of functional and grammatical roles at the functional level may result in a mapping deficit (e.g., Byng et al., 1994) and a comprehension disorder for reversible sentences (e.., Jones, 1986).

Positional: Problems at the positional level may range from incorrect word order to problems with affix retrieval (i.e., morphosyntax) and problems with word form retrieval (i.e., lexeme retrieval). Impairment at the lexeme level (i.e., positional level) would result in production of a sentence frame without any verbs (e.g., *the man the woman a question*). Thus, an intact verb lemma will activate the argument structure and result in a sentence structure but the impaired lexeme retrieval for verbs exclusively will result in a sentence that has the arguments but does not have the verb (e.g., Kim & Thompson, 2000). Omission of affixes and other grammatical markers can be attributed to impaired processes at functional level or positional level or both. A lack of specification of the grammatical marker at the message level (in the intention) or the functional level (in the lemma) can be the reason. In addition, the inability to retrieve the planning frame at the positional level may be responsible (e.g., Saffran et al., 1980b). The words produced will be simplified in terms of the relative absence of grammatical markers (e.g., *ask* for *asked*) and in terms of attachment of other phrases (e.g., *man ask* for *the man asked a question*). Simplified fragments explain the tendency to substitute singular for plural nouns and the omission of determiners.

Similarly, therapy at a particular level may affect a combination of processes or levels. For example, a semantic therapy that strengthens the meaning of a particular word should strengthen the lemma retrieval process of that particular word and also improve the input to the positional level that may result in production of that particular word in a sentence context.

Thus, GEM is able to explain some symptoms of aphasia by hypothesizing impairment at the message level, the functional level, or the positional level or a lack of correspondence between these levels. However, not all performance patterns are explained by GEM or other models of sentence production. Despite the inability of the models to explain all aphasic performance patterns, the models serve as a good basis for defining the locus of impairment, providing a means for hypothesis testing and for providing a rationale for treatment in people with aphasia. In the current study, the grammatical encoding model provides means for hypothesis testing.

4.3.1 Model-based therapy studies: Sentence production

The various models of sentence production propose several processes that take place at a particular level. For example, at the functional level, lemmas are retrieved and the functional roles and grammatical roles are specified and correlated.

4.3.1.1 Functional level

Examples of approaches that focus on the functional level include *mapping therapy* by Saffran and colleagues (e.g., Schwartz et al., 1994; Jones, 1986, Byng, 1988) and the *sentence generation training* proposed by Thompson (1998). Researchers have focused on improving mapping deficits by emphasizing these roles by different cues (e.g., colour, card cues) and therapy focusing exclusively on mapping of grammatical roles to functional roles is called *mapping therapy*. Studies dealing with 'mapping therapy' are listed in Table 4.4.

The studies described in Table 4.4 include Jones (1986), Byng (1988), Byng et al. (1994) and Schwartz et al. (1994). Mapping therapy can have a varied effect depending upon the severity of the patient's comprehension ability and the nature of the underlying seen in Byng et al. (1994). Asyntactic comprehension is a difficulty in assigning thematic roles to the parsed constituents and patients with a mild problem may have difficulty with non-canonical sentences while ones with a severe problem may have difficulty with canonical sentences as well. Moreover, many patient-specific factors could influence the response to therapy (e.g., learning style, perception of the relevance of the therapy) (Byng et al.,1994, p. 335). Patients with a pure form of agrammatism i.e., those with relatively preserved lexical processing and good syntactic knowledge as measured by grammaticality judgments showed a better response as compared to ones with severe and more complicated aphasias. Overall, these studies indicate that mapping therapy has a potential for improving sentence production with more benefits for structural measures (e.g., proportion of sentences that are well-formed, proportion of words in sentences) than morphological measures (e.g., noun/pronoun ratio, presence of determiners, noun/verb ratio) (Schwartz et al., 1995).

Another procedure that involves the functional level is called *Sentence generation training* by Thompson (1998). Sentence generation training emphasises the major functional roles to train sentence production for sentence structures NP-V-NP-PP and NP-V-NP-NP. Thompson trained the subject to produce *wh-* and NP-movement structures. The major sentence constituents (e.g., agent, action, and theme) designated for treatment were printed on cards. The subject was instructed to place the sentence constituent cards in their proper slots, one at a time, as the examiner again identified the thematic roles for each. When the cards were in correct order, the subject was instructed to read the sentence aloud. Feedback and assistance were provided (p. 148). Thompson found the following:

a) Effects of verb and verb-argument structure production treatment: The patient improved on both the categories of the sentences that were trained (p. 129).
b) Effects of training *wh*-questions: Treatment improved production of *wh*-questions and generalisation to untrained *wh*-questions was also seen.

Table 4.4. Examples of mapping therapy studies.

Researcher	**Participants**	**Therapy procedure**	**Findings**
Jones (1986) focused on the predicate and the syntactic realization of its syntactic arguments.	One with non-existent sentence structure and inability to order three given fragments	Conscious analysis of written sentences, identification of arguments through *wh*-questions. 3 times a week over 8 months	Improvement in sentence structure in speech
Byng (1988) targeted comprehension of reversible locatives for two patients.	Two patients with agrammatism	Sentence matching with the right picture. Cues such as meaning card, color coding	Marked gains in one patient with generalisation to different types of predicate
Byng et al. (1994) tried to replicate Byng (1988)	Three patients with Broca's aphasia and agrammatism	Three phases: i) linguistic and non-linguistic conceptualization of events, ii) verbal description, and iii) Carry over.	Everyone improved in verb retrieval. One showed structural changes and one improved in sentence comprehension.
Schwartz et al. (1994) focused on remediation of mapping operations	Eight chronic nonfluent aphasics with varying deficits in terms of agrammatism and word retrieval	Identification of verb arguments in a written-spoken format. Three probe questions with immediate feedback.	Two patients improved on the training task. One improved in verb retrieval. Two did not complete the study.

The studies mentioned above indicate that treatment at the functional level mainly comprises of identifying the verb and its arguments, defining the thematic roles of the arguments and correlating the thematic roles with the grammatical roles. To enable the person to learn this information, different types of clues can be used, e.g., written clues, colour coding, meaning clues etc. Treatment emphasizing the functional level may result in structural changes, i.e., improvement in the production of the arguments of a verb. In the current study, only the target verb or the noun is identified at the functional level.

4.3.1.2 Positional level

Under the positional level approach, linguistic parameters such as word order, syntactic functors (realised by closed class words) as well as morphosyntactic markings are the objectives of therapy (Springer et al., 2000, p. 286). Caramazza & Hillis (1989) propose that an impairment arising from the positional level would be evident when the symptoms of agrammatic production co-occurred with intact single word retrieval and normal sentence comprehension.

Treatment approaches that emphasise the positional level are listed in Table 4.5. Examples of treatment approaches that emphasise the positional level include the Helm Elicited Language Program for syntax stimulation (HELPSS) developed by Helm-Estabrooks and Ramsberger (1986), the language oriented therapy (LOT) by Shewan and Bandur (1986), in which task hierarchies are introduced separately for several input and output modalities and the Reduced Syntax therapy (REST) for chronic agrammatism (Schlenck et al.[11], 1995, cited in Springer et al, 2000). In these approaches, linguistic units such as word order, closed class words and morphosyntactic markings are introduced along hierarchies of complexity. In the current study, the final representation of the positional level is emphasised as one of the modules of the experimental intervention. The final representation includes word order and closed class elements but the focus is on the syntactic structure of the sentence.

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[11] Original article in a language other than English

Table 4.5. Examples of treatment approaches that emphasise the positional level.

Treatment approach	**Therapy procedure**
Helm Elicited Language Program for Syntax Stimulation (HELPSS) – Helm-Estabrooks and Ramsberger (1986)	Eleven sentence types (in order of difficulty) are presented at two levels of difficulty. Level A requires a delayed repetition while Level B requires story completion.
Language oriented therapy (LOT) – Shewan and Bandur (1986)	One of the five modalities of the communication system is oral expression. Focus is on generation of meaningful units at the phrase and the sentence level with varying difficulty. Components of LOT are stimulus, response and reinforcement.
Reduced Syntax therapy (REST) – Springer et al. (2000)	REST encourages rather than prevents the production of telegraphic style speech. Enhances linear chaining of major lexical categories and emphasises word order.

4.3.1.3 Combined Functional and positional levels

Under this approach, studies that provide treatment using both the predicate-argument structures and thematic roles, and also information about closed class morphemes, word order etc., will be discussed. The studies that provide intervention at both the functional and the positional level are described briefly in Table 4.6.

Most of the treatment studies focus on enlightening the patient, in a variety of ways, about the centrality of the predicate (verb phrase) (e.g., Mitchum & Berndt, 1994), and the relationship of the nouns in sentences to that predicate (e.g., Jacobs & Thompson, 2000). In a few studies this information is combined with information at the positional level about the phonology of verbs (e.g., Marshall et al., 1998). Other studies use explicit training in production of sentences by focusing on verbs and verb arguments (e.g., Loverso et al., 1979; Jacobs and Thompson, 2000; Schneider & Thompson, 2003). All these tasks focusing on functional level, positional level or a combination of the two levels have been successful in improved production of the targeted sentences but have achieved generalisation to untrained sentences only in a few.

Table 4.6. Examples of studies using intervention techniques targeting functional and positional levels.

Researcher	Participants	Therapy procedure	Findings
Loverso et al. (1979, 1988, 1992) designed cueing verbs treatment to generate SVO sentences	Two patients with fluent aphasia	Used verbs as the pivot stimuli and wh-questions as cues to generate complete sentences	Significant increases in overall, verbal and graphic scores. Within class generalisation
Mitchum & Berndt (1994) studied the effect of facilitation of verb production on sentence construction	One patient with Wernicke's type aphasia	Patient was asked to order a set of sequential pictures and describe each picture with a simple sentence	Marked gains in both syntactic and semantic well-formedness of sentences
Jacobs and Thompson (2000) – Linguistic Specific treatment	Four patients with Broca's aphasia showing agrammatic patterns of sentence production	Identification of verb and thematic roles followed by teaching the movement required to derive the noncanonical form. Both comprehension and production modality used	Generalisation to similar sentences and to written sentence production
Fink et al. (1997) – Modular treatment	Five patients with aphasia	Combination of Syntax stimulation (SS) and Mapping Therapy (MT) Schwartz et al. (1995)	Marked improvement for both trained and exposed verbs but not for control verbs.

Table 4.6 (contd.) Studies using intervention techniques targeting functional and positional levels.

Researcher	**Participants**	**Therapy procedure**	**Findings**
Marshall, Pring & Chiat (1998)	One participant with a strong word class effect, favoring nouns over verbs	Matching of written target verbs to pictures and performing an odd one out judgment	Improved verb naming with an increase in sentence production
Jensen (2000) focused on verb retrieval	One participant with better comprehension than production of verbs	Verb retrieval was trained in response to picture or video materials requiring sentence production	Statistically significant increase in NV(N) constructions after therapy
Raymer & Ellsworth (2002) investigated the effects of contrasting verb retrieval treatments on WR's picture-naming and sentence-production abilities	One (WR) with nonfluent aphasia and a nonfluent sentence production with mild word retrieval difficulties	Three treatment protocols: phonologic, semantic and rehearsal[12] training	Significant improvements in verb naming and sentence production
Schneider & Thompson (2003)	Seven with agrammatic aphasia	Two conditions: semantic verb retrieval and argument structure retrieval treatment	Increased grammatical sentence production with improvement in verb retrieval

[12] In rehearsal training, WR repeated the word three times, rehearsed silently, reattempted naming and then repeated the word again three times.

4.4 Lexical retrieval and sentence production

Researchers focusing on sentence production and on verbs in sentences (e.g., Loverso et al., 1979) added a new dimension of investigation: the relationship between lexical retrieval and sentence production with a focus on verb retrieval (e.g., Mitchum & Berndt, 1994; Marshall et al., 1998; Schneider & Thompson, 2003). The relationship between verb retrieval and sentence production is an important one for a clinical aphasiologist. An aphasiologist particularly needs to know how verb retrieval is related to sentence production (the type of relation) and if any change in verb retrieval would bring about a change in the sentence production ability of a person with aphasia.

Lexical hypothesis and syntactic hypothesis: In clinical aphasiology literature, a number of hypotheses exist to explain the relationship between verbs and sentence production. Variations of such hypotheses are drawn from findings in therapy studies that focus on training verbs at word level (e.g., Marshall et al., 1998) or on training verb phrases (e.g., Mitchum & Berndt, 1994) and evaluate the effect of such training on sentence production (e.g., Mitchum & Berndt, 1994; Marshall et al., 1998). Furthermore, this association of verbs and sentences is specified in models of sentence production. The linguistic notion that the verb is the most important clause element of a sentence (e.g., Quirk et al., 1972) and the results of intervention studies in aphasiology has resulted in two main hypotheses: the lexical hypothesis and the syntactic hypothesis and their variations.

Lexical hypothesis: According to Levelt (1989), grammatical encoding and phonological encoding is lexically driven:

> Nothing in the speaker's message will by itself trigger particular syntactic forms, such as passive or dative construction. Rather, there must always be mediating lexical items, which by their grammatical properties and their order of activation cause the grammatical encoder to generate a particular form. (Levelt, 1989, p. 181).

Levelt referred to the assumption that the "lexicon is an essential mediator between conceptualization and grammatical and phonological encoding" as the lexical hypothesis (1989, p. 181).

Jensen (2000) interprets Levelt's assumption to mean the following:

> General sentence schemas such as the canonical mapping schema have no independent psychological existence, but all information relevant to the

> construction of basic sentence forms is represented in the lexical entries of specific verbs. Sentence structure is directly projected from the verb, and the existence of general schemas and their possible interaction with verb-specific information in normal sentence production is not specified (p. 845).

Jensen's interpretation implies that it is the verb that drives the formation of a sentence in terms of its grammatical structure. There are two variations of the lexical hypothesis in aphasiology literature as described by Marshall (1998, p. 160):

1. Sentence production requires information that is stored within the verb representation i.e., verb lemma
2. Effects on sentence production will differ with the level of the verb retrieval impairment

Thus, based on Levelt's lexical hypothesis that emphasises the verb representation as crucial for the formation of a sentence structure, the implication drawn by aphasiologists such as Saffran and colleagues, and Marshall and colleagues is that sentence production requires information that is present in the verb representation. In patients with verb retrieval impairments, the verb lemma may be impaired resulting in the verb representation not being available in such patients. This lack of information about the verb will have a detrimental effect on sentence production.

Syntactic hypothesis: As early as the 1980s, Saffran et al. (1980a) hypothesised that a sentence production disorder was a result of the lexical deficit for verbs. This explanation was known as the Syntactic hypothesis.

Marshall (1998, p. 160) lists three variations of the Syntactic hypothesis.

1. Some degree of sentence processing (i.e., initiation of the process of sentence production) is required to activate verb entries and this fails in agrammatism i.e., the impairment is the product of a more general syntactic deficit (Marshall, 1998).
2. Verb impairment is a result of the greater morphological complexity of verbs as compared to nouns (Marshall et al., 1998).
3. The sentence production disorder is a consequence of a lexical deficit for verbs (Saffran et al., 1980b).

Garrett (1988) and Levelt (1989) have suggested that a verb's semantic representation is crucial for the construction of a sentence's predicate argument structure.

In other words, a verb representation has important information for sentence construction, i.e., defining the structure of a sentence.

Relationship between verb retrieval and sentence production: Association or dissociation[13]**:** Two types of studies are present in the literature: a) studies that do detailed assessments to explore the relationship, and b) therapy studies that target verb retrieval and evaluate the effect of improved verb retrieval on sentence production.

Bastiaanse (1995) described a patient with good verb retrieval who could construct simple declarative sentences though she had a tendency to omit the main verb. Berndt, Haendiges, Mitchum & Sandson (1997b) studied 10 chronic aphasic patients with three different patterns of noun and verb retrieval (N>V, V>N, N=V), to explore the relationship between verb retrieval and sentence processing. They hypothesised that, if verb retrieval were the cause of poor sentence production, then providing the verb would result in better sentence production. They found this effect in only two of the five verb-impaired patients. Berndt et al (1997b) found that patients who were poor at producing verbs to name action scenes produced fewer sentences, and produced simpler sentences, than did patients who were better at verb production. According to them, such simplification of sentences could arise from a variety of impairments that are completely unrelated to the verb retrieval problems, but they could also arise as a direct result of verb retrieval problems (p. 129).

In therapy studies, researchers have focused on improving verb retrieval in patients with an anticipation of improvement in sentence production. The relationship between verb retrieval and sentence production abilities is inconsistent (see Bastiaanse & Jonkers, 1998).

Marshall et al. (1998), Raymer and Ellsworth (2002) and Schneider & Thompson (2003) found an immediate effect of improved verb retrieval on sentence production (see section 4.3.1.3). In contrast, Mitchum & Berndt (1994) found that improvement in verb retrieval did not result in an improvement in sentence production. Mitchum & Berndt (1994) found that facilitation of verb production (repeated naming) did not improve

[13] Studies that have already been described in detail in the section on sentence production (see section 4.3) will not be described again.

sentence production. They explained this by saying: "the processes engaged in retrieving a verb to name a pictured action are functionally distinct from the processes needed to retrieve a verb to construct a sentence" (p. 331).

The lack of association between verb retrieval and sentence production was replicated by Reichmann-Novak & Rochon (1997). In addition, the lack of association is supported by studies such as Berndt, Haendiges & Wozniak (1997c) and Jensen (2000) who found subjects showing dissociation between verb retrieval and sentence production. Berndt, Haendiges & Wozniak (1997c) reported a subject with severe anomia who produced verbs significantly better than nouns in action/object naming tasks, but had difficulty producing and comprehending semantically reversible sentences. Jensen (2000) presented an aphasic person who had a preserved sense of canonical sentence structure in spite of a deficit in retrieving verbs.

The different results obtained in these studies could be attributed to the underlying nature of the language impairment in the patients and to the level activated as a result of the therapy task used. Mitchum & Berndt (1994) used repeated naming of each action picture until the participant could name all seven depictions of a target verb (p. 328). The therapy described in Marshall et al (1998) was qualitatively different from the simple picture naming therapy used in other studies. Therapy focused on semantic tasks to establish verb meaning. Schneider & Thompson (2003) used two different tasks: semantic verb retrieval treatment and verb argument structure retrieval treatment. They used a single subject crossover design and found that both the tasks resulted in an improvement in sentence production. Every patient was presented with the individual training item followed by a definition of the concept being trained (i.e., the meaning of motion or change of state for the semantic treatment or argument structure and thematic role information for the argument structure treatment). Every patient was asked to name the target item.

These studies show that a range of therapy techniques (from repeated naming to identifying the verb and its arguments) are effective for improving verb retrieval although their effect on sentence production is not consistent. Semantic treatments that involve verb generation in relation to noun information (in contrast to repeated practice) have been more effective in improving sentence production abilities (Mitchum and Berndt, 2001). Garrett's model and other sentence production models (e.g., Bock & Levelt, 1994, Levelt, 1999) predict that sentence production impaired by poor verb retrieval would benefit from having the verb provided. However, studies that do not show improved sentence production as a consequence of improved verb retrieval imply that "additional problems undermine sentence construction" (Mitchum & Berndt, 2001, p. 556).

Taking into consideration the results of these studies, we can say that a range of relations has been found between verb retrieval and sentence production. The findings vary from no relation to a good cause and effect relation between verb retrieval and sentence production in some persons with aphasia. These studies point to a need to explore this relationship further with a greater number of subjects with a range of language impairments.

4.5 Issues related to intervention studies

Intervention studies in the literature point to two issues. Firstly, when a researcher tries to replicate the effect of intervention on one subject, he will not necessarily find a similar effect in another patient. Secondly, it is still not clear what component of the treatment is resulting in an improvement in the target function. Moreover, people with a hypothetically similar level of impairment may not improve with the same treatment (e.g., Hillis and Caramazza, 1994).

Different patients with the same level of impairment may respond differently to a treatment approach. According to Nickels and Best, "it is not clear how the treatments are working and how they relate to levels of deficit" (1996, p. 134). This is partly due to the heterogeneity of the patients and the inability to link a deficit to a module or process within an information-processing model as a result of the lack of detail in cognitive neuropsychological models.

Byng & Black (1995) argue that therapy is more than the tasks themselves (p. 305). They propose that the form of the therapy is determined by a number of critical factors such as "language impairments and preservations, the focus of the therapy, the design of the task including the interaction between the therapist and the person with aphasia and the composition of materials" (p. 305).

The studies discussed here indicate that the therapeutic process is a complex one and a wide range of variables can affect the outcome of therapy. These variables include the participants' strengths and weaknesses, factors stressed by the task and a combination of all these variables along with the interaction between the therapist and the patient.

4.6 Issue of generalisation

Generalisation is an important factor considered during the selection of the treatment method and deciding upon the focus of therapy. When a clinician provides intervention to a person with aphasia, there is an anticipation that the training will generalise to other untrained words and to spontaneous speech as it is not possible for a clinician to train every single word. Two types of generalisation are of concern in aphasiology: response generalisation and stimulus generalisation (Thompson, 1989). According to Thompson, response generalisation refers to improvement seen in untrained stimuli and stimulus generalisation refers to improvement seen in situations that differ from those in which training takes place (p. 196). In sentence production intervention studies, the emphasis is to achieve generalisation from trained to untrained stimuli and from experimental intervention in the clinic to production of sentences in spontaneous speech.

Thompson (1989) reported that factors such as the type of probe chosen and the frequency of measurement, treatment variables such as the treatment method employed, and subject variables such as severity of aphasia, severity of apraxia of speech and motivation may be related to generalisation.

Thompson and her colleagues report that, for generalisation to occur, linguistic processes should be considered either in selecting sentences for training or in analysis of generalisation patterns (Thompson, 1994, p. 418). Evidence for consideration of linguistic processes comes from studies by Thompson, Shapiro, Ballard, Jacobs, Schneider & Tait (1997b) and Jacobs and Thompson (2000).

Thompson et al. (1997b) found that generalisation data followed a linguistically predictable pattern. Object cleft (e.g., *It was the man who the woman followed*) training influenced production of *who* questions (e.g., *who did the woman follow*?') which also rely on *wh*-movement but did not influence production of passive structures (e.g., *The man was followed by the woman*) and vice versa. Training wh-movement structures (e.g. object-clefts) resulted in generalised production of untrained wh-movement structures without influencing production of NP-movement structures. Similarly, Jacobs and

Thompson (2000) examined the cross-modal generalisation effects of training complex sentence comprehension and complex sentence production in four individuals with agrammatic Broca's aphasia who showed difficulty comprehending and producing complex, noncanonical sentences, using a single-subject multiple-baseline design. As predicted, there was no generalisation across sentence types. According to Thompson et al., *Wh-* and *NP* movements are distinct linguistic constructs; therefore, generalisation from one to the other should not be expected.

Another example of generalisation is a study by Kearns and Salmon (1984) who taught two subjects with chronic Broca's aphasia to produce third person singular auxiliary[14] *is* in sentence contexts (e.g., *Boy is drinking*) to determine if *is* production would generalise to untrained auxiliary *is* items and to copula *is* contexts (e.g., *Man is a sailor*). Kearns and Salmon found that auxiliary *is* treatment facilitated copula *is* + predicate adjective (e.g., *man is tall*) but the generalisation to predicative nominative (e.g., *man is a doctor*) and locative forms (e.g., *ball is on table*) was not consistent.

In other words, if a clinician chooses the structures that are linguistically similar then the chances of generalisation are enhanced. The linguistic aspect of treatment is important as this will reduce the work a clinician will need to do to achieve maximum generalisation. However, studies have been reported in the literature that show no generalisation to untrained stimuli. For example, Raymer & Ellsworth (2002) found significant improvements in verb naming and sentence production but no generalisation to untrained verbs.

Models that explain the process of lexical activation also address the issue of generalisation. For example, the lexical selection in Bock and Levelt's model of sentence production proposes that when a specific lexical item is activated at the functional level, not only is the target item activated but so are all semantically activated items.

Generalisation effects should be interpreted carefully because repeated naming can result in improved naming ability and practice with naming may be present during therapy such as in the form of naming controls, pre-therapy probes and post-therapy

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[14] Auxiliary training consisted of consecutive imitation and spontaneous phases, for example, "say, 'girl is washing' ".

probes (Nickels, 2002a, p. 1057). According to Nickels, the successful retrieval of an item may increase the activation of that item at the lexical level. In Nickels (2002a) the patient is exposed (here the word exposure means only visual presentation of the picture without feedback and production) to the pictures repeatedly and is trying to say the word but is unable to come with the right word. This study has implications for patients who are exposed to visual pictures. If a patient cannot retrieve words successfully and the patient gets visual exposure only, then visual exposure could activate the lexical concept provided the participant does not have a semantic impairment.

4.7 Problems with the existing studies

In an earlier section (see section 4.2.3 and 4.3), studies using a cognitive neuropsychological approach to assessment and to treatment were discussed. These studies strongly imply that models of sentence production can be used to define the locus of impairment in a patient but cannot be used to define the therapeutic task.

Researchers have focused on the relationship between verb retrieval and sentence production. Despite the number of already existing studies, the relationship between verb retrieval and sentence production is ambiguous. The different hypotheses postulated to explain the association between verb retrieval and sentence production (for example, verb as core, lexical hypothesis) have exceptions (e.g., Berndt et al, 1997c; Jensen, 2000). This is partly due to the lack of detail in the cognitive neuropsychological models used to explain this relationship and partly due to the heterogeneity of patients.

Studies often do not differentiate the morphological and the syntactic features of agrammatism in the clinical treatment literature (Schwartz et al., 1995). Based on this finding, Schwartz et al. (1995) proposed a modular approach to treatment of agrammatism and incorporated a sequential combination of Syntax Stimulation (SS) and Mapping Therapy (MT). In general, studies focus on syntactic features (e.g., Thompson and colleagues, 1997) but very few studies have focused on verb inflection in sentence production studies (e.g., Mitchum & Berndt, 1994). In addition, the role of nouns in sentence production has not been explored.

These issues raise the need for studying the relationship between lexical retrieval and sentence production taking into consideration both nouns and verbs and differentiating the morphological and syntactic features of agrammatism and paragrammatism.

4.8 Present study

Taking into consideration the limitations of cognitive neuropsychological approaches in specifying a therapy task, the present study provides intervention at three different modules (word module, affix module and sentence module) to patients with aphasia. The modules of intervention are based on GEM, a consolidated model of sentence production. Patients with aphasia with a global inability to produce sentences, (i.e., irrespective of whether the deficit is at the functional level or the positional level) will be selected. The same intervention will be provided to all participants irrespective of the level of impairment within GEM. The present study differentiates the morphologic and syntactic features of sentence production impairments by choosing different modules of intervention. The affix module for the morphological features will target inflectional affixes. The sentence module for the syntactic features will target the syntactic structure of a sentence. In addition, the present study focuses on both nouns and verbs to analyse the relationship between noun retrieval and sentence production, and between verb retrieval and sentence production by considering two different types of sentences: sentences with SVO structure that are driven by the verb present in the sentence, and SVC structure that has a copula and that emphasises the noun and the complement. The emphasis of the present study is only on use of oral (spoken) cues in the experimental intervention in association with a visual cue (i.e., a picture). It is an experimental study that examines the validity of GEM (based on Garrett, 1984; Levelt, 1989, 1999; Bock & Levelt, 1994) by analyzing the responses of the participants to the experimental intervention. The present study will have clinical implications for the appropriate focus of the clinical aphasiologist's treatment.

5 Chapter Five: Design and Methodology – Study 1

5.1 Aims of the study

The purpose of the current study was to use a cognitive neuropsychological approach for intervention for sentence production disorders in people with aphasia to test the validity of the grammatical encoding model (GEM) used in the study. Generally, in a model based intervention, a detailed assessment is performed to find a functional locus of impairment and intervention is structured around the impairment. In contrast, in the present study, the emphasis was intervention at three different levels of GEM without determining the locus of impairment in the participants. The intervention was based on a model of sentence production for normal speakers. GEM was tested by evaluating the responses of the participants to intervention based on the model. The responses were analysed to see if the responses were the same as the predictions of GEM. The aims were:

1. To examine whether an experimental intervention based on GEM would result in an increase in production of the targeted sentences in people with aphasia

   Specific aims

   i) To assess the effect of three hierarchically structured intervention modules on trained items (i.e., words, word affixes and sentences; see section 5.2).

   ii) To examine the relationship between verb retrieval and sentence production

   iii) To examine the relationship between noun retrieval and sentence production

   iv) To examine the relationship between affix retrieval and sentence production

2. To examine whether effects on one particular grammatical class (i.e., verbs) as a result of successive interventions in three hierarchical modules based on GEM will generalise to another grammatical class (i.e., nouns) or vice versa.
3. To examine whether effects seen on trained stimuli as a result of successive interventions in three hierarchical modules based on GEM will generalise to untrained stimuli.
4. To examine whether successive interventions in three hierarchical modules based on GEM will generalise to an increase in the number of utterances produced and an increase in the number of verbs produced in spontaneous speech.
5. To discuss the implication of the results from aims 1-4 for GEM.

5.2 Modules of intervention

The emphasis of the intervention was on the syntactic structure of a sentence that related to grammatical encoding in GEM. The first module of intervention was the **word** module where the aim was to teach a patient to say a single word. This module corresponded to the lemma retrieval of the functional level. Both verbs and nouns were trained. The word module was incorporated because many people with aphasia find it difficult to produce verbs and nouns in isolation.

The second module of the intervention was the **affix** module. This corresponded to the retrieval of affixes at the positional level and targeted the closed class vocabulary[1]. Affixes were chosen because they form a part of the closed class vocabulary and they are affected both in patients with agrammatism and paragrammatism. The aim was to teach the past tense affix for the verbs and to teach the possessive affix for the nouns.

The third module of the intervention was the **sentence** module. This corresponded to the final representation of the positional level. The sentence module

[1] For the current study, inflectional affixes are considered a part of the closed class vocabulary.

was essential to provide the information present in a sentence and to evaluate the necessity of sentence level training.

The order of the modules was the same in all participants: word module followed by the affix module and the sentence module because the information flow in the model is from top to bottom, i.e., from message level to functional level to positional level. The stimuli in the three modules consisted of verbs and nouns (see Table 5.1).

Table 5.1 Modules of the experimental intervention based on GEM.

Stimuli	Level of model	Module of intervention	Example
Verbs	Functional	Word module	Grate
	Positional	Affix module	Grated
	Positional	Sentence module	The woman grated a carrot
Nouns	Functional	Word module	Man
	Positional	Affix module	Man's
	Positional	Sentence module	The man's arm is hurt

A combination of verification with corrective feedback and production was chosen as the intervention task. Verification relates to lemma at the functional level and production relates to lexeme at the positional level in GEM.

5.3 Sentence production

Sentences can be canonical and non-canonical. Canonical sentences in English are sentences with the word order subject-verb-object (SVO) and the order SVO is the canonical order in English. In the clinical aphasiology literature, researchers focus on canonical sentences (e.g., Loverso et al., 1979; Holland and Levy, 1968) and non-canonical sentences (e.g., object cleft sentences as in Thompson et al., 1997). Canonical sentences are used in this study because normal speakers less often produce non-canonical sentences as compared to canonical sentences in everyday conversation[2].

Canonical sentences with three different grammatical structures were chosen for the study. The target sentences for verbs were subject-verb-object sentences (SVO, e.g., *the woman wiped the board*) and subject-verb-indirect object-direct object sentences (SVOO, e.g., *the woman asked the man a question*), referred to as the verb sentences. The target sentences for nouns were subject-verb-complement sentences (SVC, e.g., *the postman's bag is open*), referred to as the noun sentence. We will now describe the construction of a verb sentence and a noun sentence in terms of GEM.

5.3.1.1.1 Verb sentence: The woman squeezed a lemon

The message representation (or the intention) is that the speaker wants to talk about a woman who did something to a lemon. At the functional level, the lemmas of the verb *squeeze*, nouns *woman* and *lemon* are activated. In addition, the lemma of the verb *squeeze* will activate the information that it is a transitive verb and will need a subject and an object. Specification of the functional roles of *agent, action* and *theme* will take place. Further, these will be correlated with the grammatical roles such as subject (*woman*), verb (*squeeze*) and object (*lemon*). At the positional level, the word order will be imposed. The intention to talk about an action that is in the past will activate the tense specification that will be specified by the verb lemma in the form of diacritics. The word forms of all the lemmas activated will be retrieved and also the function words *the* and *a* along with the affix *-ed* will be retrieved based on the diacritics specified by the lemmas and also by the message. The final representation will be *the woman squeezed a lemon* that will be phonetically encoded and sent to the articulator for motor encoding processes to result in a spoken utterance.

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[2] Frequent use of canonical sentences is apparent because subject-verb-object is the dominant sequence of constituents of sentences in English (Poole,1999).

5.3.1.1.2 Noun sentence: The man's arm is hurt

The message representation is that the speaker wants to talk about the arm of the man and the condition of the arm. At the functional level, the lemmas activated will be nouns *man* and *arm*, the copula *is* and the adjective *hurt*. In such sentences, the copula specifies that the other parts of a sentence are a noun phrase and a complement. But the driving force to choose a particular noun phrase and a complement is the intention of the speaker that is facilitated by the picture presented to the patient. Thematically, *man arm* will be *experiencer* and *hurt* will be its *attribute*. Grammatically, *man arm* will be assigned the subject, and *hurt* will be assigned the complement. At the positional level, the word forms of *man, arm, is* and *hurt* will be retrieved, and the word form of the inflectional affix *'s* and the function word *the* are retrieved. The word order is imposed and the final representation at the positional level is *the man's arm is hurt* that is phonetically encoded and sent to the articulator for motor encoding processes to result in a spoken utterance.

5.4 Characteristics of impairment level

According to GEM, impairment at different levels may affect sentence production in different ways. For example, impairment at the functional level may affect retrieval of the lemma (associated with the lexical concept) or function assignment or both processes. Depending upon the process impaired at a particular level, sentences may be produced with incomplete arguments or with wrong function assignment. The effect of impairment at different levels is summarised in Table 5.2.

Table 5.2 Effect of impairment level on sentence production

Impairment level	Effect on sentence production
Message level	May affect the diacritics and the verbs used
Functional level	
Lemma	May affect the number of arguments activated and the subcategorisation rules in relation to the verb activated
Function assignment	May affect the assignment of grammatical roles and functional roles
Positional level	
Lexeme retrieval	May affect the retrieval of lexemes in relation to the lemmas activated
Planning frame	May affect the retrieval of affixes and the associated features
Word order	Sentences may have the wrong word order in relation to the concept explicit in the picture

5.5 Changes anticipated on training

Different changes are anticipated as a result of intervention in the different modules for the two types of sentences, i.e., verb sentence and noun sentence.

Verbs – word module: The verb in isolation (i.e., the word module) would activate the verb lemma at the functional level. A verb lemma would activate the meaning and the syntactic information (i.e., the argument structure of the verb) related to the verb. At the positional level, the lexemes for the activated verb and verb arguments will be retrieved. The intervention task focuses on the functional level and the positional level. Verification of the word would activate the verb lemma. Verification at the word module emphasises the meaning and the production targets the word form. The intervention task at the word module strengthens the link between the lemma and the lexeme. In other words, the task will help in the retrieval of the lexemes of the trained items. The activation of the verb lemma would help in the retrieval of arguments that would result in an increase in the number of trained sentences produced.

Verbs – affix module: The verb affix would help in retrieval of the planning frame at the positional level because as proposed by GEM, the affixes are retrieved in a planning frame. Word-affix verification and production will help in the retrieval of the lexemes related to verbs with affixes. The activation of the planning frame would result in an increase in the number of sentences produced.

Verbs – sentence module: The complete sentence would retrieve the final representation of the sentence at the positional level. Sentence verification and production would help in the production of complete sentences.

Thus, each module will activate the sentence indirectly resulting in an overall improvement in the production of sentences either in terms of the number of arguments produced or in terms of the closed class vocabulary produced or both.

Noun modules: The noun in isolation (i.e., the word module) would activate the noun lemma at the functional level. A noun lemma would activate the meaning related to the noun. The noun affix (i.e., the affix module) would help in retrieval of the planning frame of the sentence because as proposed by GEM, the affixes are retrieved in a planning frame. The complete sentence (i.e., the sentence module) would retrieve the final representation of the sentence at the positional level. The affix module here may retrieve the planning frame but the structure of the sentence is going to be specified by the verb (i.e., the copula). Thus, only the sentence module will result in improved production of noun sentences.

All three modules for verbs and for nouns would result in the production of verb sentences and noun sentences. An increase in the production of sentences would be reflected in everyday spontaneous speech because the process of sentence formation during the intervention would be similar to the one in everyday life.

Table 5.3 outlines the proposed effect of the intervention task in the three different modules along with the possible obstacles to the proposed effect. Thus, a participant may show improvement in the activation of a particular process but an associated impaired process may hinder the observation of the improved activation. For example, the word module may strengthen the links between the lemma and the

Table 5.3 Prediction of effect of intervention task in the three modules on sentence production

Task	**Proposed Effect**	**Obstacles**
Word verification and production (word module)	Target the word that should activate the associated lemma. The lemma would help in lexeme retrieval. Verification and production would strengthen the links between the activated lemma and the lexeme. The lemma would activate the argument structure of verbs and help in the production of sentences.	Inactivation of lemma e.g., lemma of verb '*squeeze*' does not activate that it is a transitive verb
Word-affix verification and production (affix module)	Target the word with the affix. The affix retrieval would retrieve the planning frame.	No affix retrieval
Sentence verification and production (sentence module)	Target the full sentence structure and provide the complete information necessary to produce a sentence	Inability to produce a sentence planning frame that will affect the production of the parts of the sentence

lexeme but the argument structure may not be evident in the sentences produced because of impaired lexeme retrieval.

5.6 Hypotheses and predictions

In this section, the hypotheses of the current study will be explained in terms of predictions based on GEM and in terms of predictions based on literature, if any. These hypotheses relate to the aims of the study (see section 5.1).

5.6.1 Hypothesis 1

An experimental intervention derived from GEM will result in an increased production of target sentences in patients with aphasia.

5.6.1.1 Hypothesis 1 (i)

Each intervention module will result in an increase in the accurate production of trained items in that particular module. The word module will result in an increase in the production of trained verbs and trained nouns. The affix module will result in an increase in the production of verb-affixes and noun-affixes. The sentence module for both verbs and nouns will result in an increase in the production of trained sentences.

Treatment of verbs or nouns in the word module will not generalise to verbs or nouns in the affix module because affixes are stored separately from the verb stem/noun stem but there is a possibility of generalisation of only the stem of the verb or noun from word to affix level. Treatment of the simple past affix will not generalise to possessive noun affix or vice versa because they belong to different grammatical classes and they are stored separately.

5.6.1.2 Hypothesis 1 (ii)

Association between verb retrieval and sentence production will be established by the results of the experimental intervention, i.e., improvement in verb retrieval will generalise to an increase in the production of target sentences because the lemma of the verb once retrieved will activate the argument structure and the planning frame for the sentence according to GEM.

5.6.1.3 Hypothesis 1 (iii)

An association between noun retrieval and sentence production will not be established by the results of the experimental intervention, i.e., improvement in noun retrieval will not generalise to an increase in the production of target sentences because the noun lemma does not activate the argument structure.

5.6.1.4 Hypothesis 1 (iv)

Improvement in affix production for verbs and nouns will generalise to an increase in the production of target sentences because the retrieval of affixes should indirectly retrieve the planning frame of the sentence.

5.6.2 Hypothesis 2

Improvement in one grammatical class will not result in generalisation to any other grammatical class in any of the modules, i.e., in word-, affix- or sentence module because nouns and verbs belong to different grammatical classes and information about grammatical class is retrieved along with the lemma at the functional level.

5.6.3 Hypothesis 3

Improvement of trained stimuli will result in generalisation to untrained stimuli in each module within each grammatical class, i.e., in the word module there will be a generalisation from trained words to untrained words; in the affix module there will be a generalisation from trained word affixes to untrained word affixes and in the sentence module, there will be a generalisation from trained sentences to untrained sentences. Generalisation from trained to untrained items is expected both because of the intervention task and clinical aphasiology literature (see chapter 4, section 4.6). The intervention task of verification and production strengthens the association of the lemma and the lexeme. The lexemes trained should activate semantically related lexemes (e.g., Bock & Levelt, 1994[3]). Activation of semantically related items does not ensure improvement of all items in the generalisation set because the verbs were not selected based on semantic similarity but it is anticipated that at least a few items will be activated. All verbs fall into the semantic category of activity verbs. The majority of nouns in the treated and the untreated sets fall into the semantic category of occupations. During affix module and sentence module, the process of producing an affix or a sentence is the same for

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[3] According to Bock & Levelt (1994, p. 234), when a specific item is activated at the functional level, all semantically related items are activated along with the target item.

both untrained and trained stimuli. Though the rules are not made explicit during the intervention task, they are implicit in terms of the structure of a particular sentence. For example, during the sentence module, the use of a picture and pointing to the different components of the sentence (excluding the function words and affixes) using a mouse provides information about how the participant can form a sentence. Thus, taking into account the linguistic similarity and the similarity of the process in both untrained and trained items, generalisation is expected.

5.6.4 Hypothesis 4

Improvement resulting from the experimental intervention will result in generalisation to spontaneous speech (i.e., as measured by an increase in the total number of utterances and in the number of verbs) as a cumulative effect of all the three modules.

5.7 Study design

A single subject multiple baseline design across behaviours was used in the current study. An experimental model-based intervention is designed to test the validity of GEM. Three different modules of intervention are designed (i.e., word module, affix module and sentence module). Both verbs and nouns will be trained at the three modules. After the intervention, a maintenance probe is added to find out if the changes as a result of intervention are maintained after the withdrawal of intervention. The independent variable is the treatment and the dependent variables are performance of verbs, verb affixes, verb sentences, nouns, noun affixes and noun sentences. In the current study, intervention is to be introduced sequentially, i.e., verbs followed by verb affixes followed by verb sentences and nouns followed by noun affixes and noun sentences. The order of presentation of noun modules and verb modules will be counterbalanced. The sequential order within verb modules and noun modules is the same for all participants.

Participants will be selected based on the inclusion criteria, exclusion criteria and the screening protocol. Ideally, patients with poor sentence production abilities but relatively better lexical retrieval are required so that they would have room for improvement as a result of the intervention provided. A pre- and post-intervention battery was designed to assess the abilities of the participants prior to and after the experimental intervention.

The design of Study 1 as discussed was tested using a pilot study with one participant. Because no changes were made, the subject in the pilot study became participant 1 in Study 1.

5.8 Methodology

This section explains the decisions made in terms of the research design, inclusion and exclusion criteria and evaluation protocol for the participants, the test batteries used followed by the procedures used and the statistical measures used to analyse data.

5.8.1 Research design

A single subject multiple behaviours baseline design was used in the current study taking into consideration the technical advantages and the popularity of single subject designs in aphasiology. Technical advantages of single-subject designs include identifying functional relationships between an independent variable and a dependent variable, examination of intersubject variability and examination of intrasubject variability (McReynolds & Thompson, 1986, p. 197). Moreover, single-subject designs provide internal validity because they allow a researcher to compare the behaviour of a subject during no-treatment conditions with the subject's behaviour during experimental conditions. Control for extraneous variables is demonstrated with the individual subject because those extraneous variables (if any) will play a role in both the treatment and no-treatment conditions. Single subject research designs are popular in aphasiology because they can result in valid experiments despite the heterogeneity of patients and can provide valuable information regarding individual behaviour.

Single-subject research designs yield sequences of performance-over-time data called time series data (Robey, Schultz, Crawford & Sinner, 1999, p. 455). A multiple baseline design across behaviours allows a researcher to monitor the effect of an independent variable (i.e., treatment) on one behaviour while concurrently probing the other behaviours. Stable performance during measurement indicates that the behaviour is not influenced by the passage of time and other activities such as treatment. Lack of stability indicates that change in behaviour might be a result of direct treatment aimed at that behaviour, or change in behaviour of untreated stimuli may be a result of generalisation from the behaviour being treated.

5.8.2 Inclusion and exclusion criteria

The inclusion criteria of the participants were:

- Single incidence of stroke at least 6 months post onset to eliminate any chances of further spontaneous recovery in the participants and to show that the improvement seen (if any) in the chronic patients was a result of the intervention.
- Age range 65-80 because a majority of patients affected with stroke in Christchurch was above the age of 65.
- Right-handedness so that the left hemisphere would be dominant for language.
- English as the first language because the aim was to study the syntactic structure of the sentences produced in English language.

Patients with a history of dementia, documented moderate to severe dysarthria, documented moderate to severe apraxia and severe hearing loss were not to be included in the study because of the associated disorders in speech and language related to these disorders. The associated disorders may reduce the chances of improvement because of a different etiology and a different aspect of speech and language being affected.

5.8.3 Evaluation protocol

An evaluation protocol was used in order to recruit participants with comprehension that was good enough to understand the intervention task but with poor sentence production ability. In addition, the participants were required to have a reliable *yes-no*, good hearing and good cognitive abilities to perform the intervention task. Thus, the evaluation protocol included the following:

- **Auditory comprehension**: comprehension of word discrimination, body-part discrimination, commands, and complex ideational material using the

Boston Diagnostic Aphasia Examination (BDAE). The percentile range of comprehension scores obtained for the six participants varied from 0-90. Two of the participants (P3 and P6) were not able to perform well on the BDAE. Despite their low scores, P3 and P6 were able to follow the instructions and do the required task.

- **Yes-no reliability:** ten questions from Western Aphasia Battery (Kertesz, 1982). For the *yes-no* to be reliable, the person had to respond correctly to at least seven out of the ten questions, selected from WAB. However, one of the participants (P3) had a perseveration problem of saying *No* for everything even when he wanted to say *Yes* – this was resolved by presenting him with two cards. One of the cards had 'YES' written on it with a 'tick' symbol and the other had 'NO' written on it with a 'cross – X' symbol and the participant was asked to point to one of them in response to the question. P3 was able to do this 90% of the time and therefore he was selected to be one of the participants. P6 was also presented with cards during the intervention.
- **Sentence production ability:** description of ten action pictures. The participant was asked to describe what the person was doing in the picture, in a simple sentence. A participant was considered to have sufficient impairment if he/she produced less than 80% of the sentences correctly.
- **Cognitive ability using Mini Mental State examination (MMSE):** Desmond et al (1998) used a cut off point of <24 for MMSE score in patients with stroke. Taking into consideration the large component of verbal responses required in MMSE, a score less than 24, with a lack of documented history of cognitive problems and dementia was considered appropriate for participation in the current study. For example, P1 and P2 both had a score of 22. Two of the participants (P3 and P4) were not able to perform well on the MMSE because of their poor verbal output. However, their lack of history of dementia and cognitive problems made them eligible participants. P5 had a score of 24 and P6 was not able to do the MMSE test.
- **Hearing screening:** at 500 Hz, 1 kHz and 2 kHz. Some of the participants in the presbyacusis age range had poorer hearing than the screening thresholds

(i.e. poorer than 40 dB HL) at one of the frequencies. These subjects were taken as participants in the study as their lower thresholds at high frequencies did not affect their ability to communicate or comprehend. None of the participants was using a hearing aid.

5.8.4 Pre and Post intervention battery

All sentences used in the study involved production of verbs and nouns. Thus, it was important to assess the nouns and verbs available to the participants before the intervention to make a comparison between their overall ability before and after intervention in the production of nouns and verbs. A test battery was designed to assess these abilities. The test battery used during pre-intervention testing was re-administered after the experimental intervention to examine if the intervention resulted in a change in the overall language ability of the participants.

The pre-intervention test battery consisted of the Short form of the Boston Diagnostic Aphasia Examination (Goodglass, Kaplan and Barresi, 2001), the North Western University Verb Production Battery (Thompson et al, n.d.), the North Western University Sentence Comprehension Test for Aphasia (Thompson, Ballard and Tait, 1995), and subtests from the Psycholinguistic Assessments of Language Processing in Aphasia (PALPA, Kay, Lesser and Coltheart, 1992).

The various tests evaluated different features of a participant's language and comprised:

- The Short form of Boston Diagnostic Aphasia Examination (BDAE, Goodglass, Kaplan and Barresi, 2001) tests the patient's auditory comprehension, oral expression, reading and writing skills. Scores of BDAE are in percentiles.
- North Western University Verb Production Battery (Thompson et al, n.d.) has three subtests: verb comprehension, confrontation naming, and sentence production (Thompson, Lange, Schneider and Shapiro, 1997a). Several different types of verbs were tested for both comprehension and naming, including one-place verbs such as *sleep*, two-place verbs such as *fix*, and three-place verbs such as *give*. Verbs were differentiated into obligatory and optional verbs. The battery consisted of five obligatory one-place verbs, five obligatory two-place verbs, two

obligatory three-place verbs, ten optional two-place verbs and sixteen optional three-place verbs. Action pictures depicting each verb were used. To assess comprehension, each participant was asked to point to the verb named (out of four pictures), and to assess confrontation naming, each participant was asked to name the action in individual pictures. To elicit verbs in sentences, pictures with arrows to denote objects or people that represented arguments of the verb, were presented to the participants. Norms are not available for this test.

- The North Western University Sentence Comprehension Test for Aphasia (SCT, Thompson, Ballard and Tait, 1995) examines comprehension of active, passive, subject-relative, and object-relative sentences (20 exemplars of each). Semantically reversible picture pairs are presented and the patient points to the one that matches the target sentence. Normative data are not available for this test.
- Psycholinguistic Assessments of Language Processing in Aphasia (PALPA, Kay, Lesser and Coltheart, 1992) subtest numbers 47 and 53 (Spoken word-picture matching and Spoken picture naming) test the comprehension and production of nouns. Normative data for subtest 47 and for subtest 53 for the normal population are available.

5.8.5 Materials used in the study

Two types of stimuli were chosen to be trained: verbs and nouns. A total of 30 verbs and 30 nouns were selected for the research project. Of the 30 verbs and nouns, 10 were selected for training and 20 were chosen for testing generalisation. Care was taken to include verbs and nouns that would be meaningful to the participants in everyday life.

5.8.5.1 Verbs

The main criterion for selecting verbs was their argument structure. Two types of verbs, transitive (obligatory two-place) and ditransitive (three-place verbs) were chosen. As enough obligatory three-place verbs that could be pictured were not available, both obligatory and optional three-place verbs were chosen. For example, *read* is a verb that can be intransitive, transitive and ditransitive (i.e., *she is reading,* *she is reading a book, she is reading the boy a book*) while *put* is a verb that can be only ditransitive (i.e., *she put a book on the shelf*). Verbs such as *read* that can have more than one structure will be called optional ditransitive (similar to optional three-place verbs). In the trained set, *ask* and *throw* are optional ditransitive verbs. In the untrained set, *wash, read, buy* and *build* are optional ditransitive verbs. After finalizing the verb list, it was realised that three of the verbs were not ditransitive but were transitive optional. These three verbs were *spread, hang* and *take.* The verb *spread* was one of the trained verbs and the verbs *hang* and *take* were untrained verbs

Other factors taken into consideration were frequency, picturability, instrumentality, imageability and homophony. All verbs that had a homophonous noun (see chapter 4, section 4.2.1.2) were deleted from the intervention list to resolve any ambiguity that may exist because of the presence of the same word as verb and as noun. Low frequency words were included to increase the level of difficulty for the participants (seven of the trained items had a frequency less than 100 per million according to Francis and Kucera, 1982). During the selection of verbs at the word level, care was taken to include verbs with a similar number of syllables so that addition of syllables would not be an extraneous variable. Table 5.4 shows the list of transitive and ditransitive verbs in the trained category. Table 5.5 shows the list of transitive and ditransitive verbs in the untrained category. None of the verbs from the pre-intervention battery were included in the training or the generalisation stimuli. All the pictures used with the respective verbs are presented in Appendix A.

The verbs in the trained category and in the untrained category differed in terms of regularity and the frequency of occurrence. A total of six irregular verbs and four regular verbs formed the trained category. In the untrained category, a total of ten verbs each were regular and irregular. In terms of frequency, seven of the ten trained verbs were of low frequency (<100 per million) and three were high frequency verbs. In the untrained category, 12 verbs had a low frequency of occurrence and eight verbs had a high frequency of occurrence. Both regular and irregular verbs were included in the study because affixes for regular verbs are

Table 5.4 List of verbs in the trained category. Verb frequencies for the lexical stem in written English are in brackets. Transitive optional verbs take SVOA structure instead of the SVOdOi structure.

Regular (n=4)	Irregular (n=6)	Sentence
Transitive verbs (n=4)		
Squeeze (11)		The woman squeezed a lemon
Shred (3)		The woman shredded some paper
	Tear (1)	The woman tore a piece of paper
	Choose (50)	The boy chose a pair of boots
Transitive optional (n=1)		
	Spread (83)	The woman spread jam on the bread
Ditransitive verbs (n=5)		
Lean (20)		The woman leaned a crutch against the wall
	Give (391)	The man gave the woman a bottle of wine
Ask (128)		The woman asked the man a question
	Feed (123)	The woman fed yoghurt to the boy
	Throw (42)	The woman threw a ball to the boy

retrieved differently from irregular verbs according to GEM (see chapter 2, section 2.3.3.4).

Two volunteers were asked to perform the actions and still pictures were taken using a digital camera. These pictures were transferred from the digital camera to the computer and then were edited and quality enhanced using Adobe Photoshop application and saved in a jpeg (joint picture enterprise group) format. Each picture was then presented to participants in a different html (hypertext markup language) page through an Internet Explorer browser.

In the three different modules of intervention, three different forms of the verbs (e.g., *ask, asked, the woman asked the man a question*) were used. In the word module, only the verb in isolation was used; and in the affix module, the same verbs

Table 5.5 List of verbs in the untrained category. Verb frequencies for the lexical stem in written English are given in brackets. Transitive optional verbs take SVOA structure instead of the SVOdOi structure.

Regular (n=10)	Irregular (n=10)	Sentence
Transitive verbs (n=6)		
Wipe (10)		The woman wiped the board
Chop (3)		The woman chopped a pepper
Sort (164)		The woman sorted the money
Share (98)		The man and the woman shared a drink
Assemble (9)		The woman assembled the lamp
	Break (88)	The woman broke a stick
	Make (794)	The boy made a castle
	Hold (169)	The woman held the baby
Transitive optional (n=2)		
	Take (611)	The woman took the children to the swimming pool
	Hang (26)	The woman hung a jacket on the hook
Ditransitive verbs (n=12)		
Serve (107)		The waiter served them the dessert
Wash (37)		The woman washed a t-shirt for the boy
Organise (14)		The woman organised a birthday party for her son
Show (287)		The woman showed the man some photographs
Offer (80)		The woman offered the man a biscuit
	Read (173)	The woman read the boy a story
	Buy (10)	The man bought boots for his son
	Send (74)	The woman sent her a letter
	Build (86)	The woman built a tower for the boy
	Tell (268)	The woman told them the way

with a simple past affix (-ed) were used. To elicit the simple past, a sequence of two pictures was used. The first picture showed the person performing the action while the second picture showed that the action was completed. The same picture sequence that was used to elicit the past tense in the affix module was used to elicit sentences in the sentence module.

5.8.5.2 Nouns

Nouns that could take a possessive affix were chosen for both the trained and the untrained category. The list of selected nouns consisted of a large number of animate nouns and a few objects that could take a possessive e.g., *fire engine, train.* Pictures from "Colour cards – Occupations" (Franklin et al, 1992) were scanned and used. The remaining pictures were selected from pictures available on the internet. The name agreement for the images selected was verified by testing on ten normal speakers. A list of nouns in the trained category is presented in Table 5.6. Table 5.7 presents the nouns in the untrained category. All the pictures used with the respective nouns are presented in Appendix A.

Table 5.6 List of nouns in the trained category. Frequency represents noun frequencies in written English.

Noun	Frequency	Sentence
chef	9	The chef's meal is tempting
cobbler	1	The cobbler's shop is messy
cow	16	The cow's face is black
donkey	1	The donkey's face is big
Fire engine	2	The fire engine's ladder is high
florist	1	The florist's bouquet is beautiful
girl	220	The girl's hair is wet
man	1207	The man's arm is hurt
Postman	2	The postman's bag is open
teacher	80	The teacher's class is active

Table 5.7 List of nouns in the untrained category. Frequency represents noun frequencies in written English.

Noun	Frequency	Sentence
artist	57	The artist's painting is big
cleaner	9	The cleaner's machine is huge
dentist	12	The dentist's drill is sharp
doorman	4	The doorman's uniform is smart
draftsman[4]		The draftsman's work is detailed
fisherman	5	The fisherman's catch is big
gardener	4	The gardener's hoe is long
lion	6	The lion's mane is hairy
messenger	10	The messenger's bag is full
monkey	265	The monkey's tail is long
patient	86	The patient's face is calm
plasterer	1	The plasterer's shirt is dirty
reporter	20	The reporter's camera is huge
roofer	1	The roofer's job is risky
secretary	191	The secretary's desk is organised
soldier	39	The soldier's truck is big
strawberry[5]		The strawberry's skin is shiny
train	82	The train's design is modern
Wood carver	1	The wood carver's figure is intricate
zebra	1	The zebra's coat is striped

Nouns within the trained and the untrained category varied in terms of their frequency of occurrence. In the trained category, eight nouns had a low frequency of occurrence and two had a high frequency of occurrence. In the untrained category, eighteen of the twenty nouns had a low frequency of occurrence.

[4] Frequency not available for draftsman but for architect (20)

[5] Frequency available only for plural, i.e. strawberries (2)

In the three different modules of intervention, three different forms of the nouns (e.g., *chef, the chef's meal, the chef's meal is tempting*) were used. The same picture that was used in the word module was used for both the affix module and the sentence module.

The format of the sentence for the verbs was different from that of the nouns (see section 5.3). The main reason for the different structure in the nouns was to exclude any main verbs in noun sentences (besides the copula), to avoid any cross-generalisation between verb stimuli and noun stimuli due to the presence of other verbs in noun sentences. Nouns in the verb sentences are unlikely to affect the nouns in the noun sentences because none of the nouns used in the current study were included in the noun sentences. Moreover, nouns do not have an argument structure to activate a similar argument structure in other nouns, unlike verbs that can affect the production of sentences because of a similarity in the argument structure.

5.8.6 Testing of materials using normal speakers

A total of ten normal speakers in the age range of 50-70 were selected for evaluating the responses of normal speakers to the pictures to be used in the study. For verbs, the normal speakers were asked to provide one word for *what the person was doing* in the picture at word level, to provide one word for *what the person did in the picture* for affix level and describe *what the person did in the picture* using a sentence at sentence level. For nouns, the speakers were asked to produce one word for the *object, animal or person* in the picture in the word module. In the affix module, the person was asked a question such as *whose meal* and in the sentence module he was asked to make a sentence with a particular grammatical structure. The same instructions as those for baseline testing were used (see Appendix B). Only pictures that elicited a consistent response (at least 90%) were chosen for the study. Pictures that did not elicit a consistent response for verbs (e.g., *bring, carve*) and nouns (e.g., *welder, drummer*) were eliminated from the study.

Once the pictures were finalised for the nouns, the choice of adjectives as complements in the noun sentences was verified using five normal speakers. The normal speakers were presented with a picture and the spoken sentence and the person was asked to verify the sentence by saying *yes* or *no*.

5.8.7 Procedures

5.8.7.1 Baseline procedure

A baseline was obtained for all the three forms of verbs and nouns (i.e., in isolation, with an affix and in a sentence) for each participant. The total number of sessions for baseline and for each module was fixed before the start of the intervention to maintain a consistency in the number of sessions for participant. The multiple baseline design used in the study resulted in ongoing probe measures for the linguistic behaviours that had not yet been trained. Therefore, the total number of baseline sessions was greater in the affix module and the sentence module. The criterion measure used was number of sessions rather than a percentage of correctly produced target stimuli in order to maintain a consistency in the number of sessions that every participant had. Consistency was important to ensure that the participants were exposed to the stimuli for same number of times.

Robey et al. (1999) provided a detailed analysis of published single subject results in aphasiology and reported that sixteen of the sixty-three studies had three observations in the baseline period. They found that the average for the initial baseline periods was four (Robey et al., 1999, p. 451). Robey et al. recommend that extended baseline series be used as in multiple baseline designs. A total of five sessions were proposed for baseline for the first module in the present study: a) in anticipation that five sessions would be enough to obtain a stable baseline, and b) to have a consistent number of baseline observations across participants. After the fifth session, the baseline testing for verb and noun affixes and verb and noun sentences was done every alternate session until the start of the intervention for the affix module and the sentence module, as is the case in multiple baseline designs. There were a total of twelve sessions in the affix module and a total of eighteen sessions in the sentence module respectively. The pictures used during baseline were the same as the ones used for intervention.

The specific instructions for obtaining baseline in each module are presented in Appendix B. For all the phases of the study, i.e., baseline, intervention and generalisation, two practice items were used to make each participant familiar with the task. During the practice items, a mouse was used to point to the object or the action in question. Pointing with a mouse was not used during baseline testing of the items to be trained.

5.8.7.2 Experimental intervention

The intervention consisted of facilitation, feedback and production in the word module, the affix module and the sentence module. Six treatment sessions each were undertaken for every dependent variable i.e. for verbs, nouns, verb affixes, noun affixes, verb sentences and noun sentences.

Facilitation was done by using a word-verification approach and a sentence verification approach (Brookshire & Nicholas, 1980) followed by oral production. A verification approach followed by oral production was used to activate the lemma at the functional level and the lexeme at the positional level. The aim was to activate the lemma and the lexeme of a particular word so that patients with impairment at either of the two levels would be able to benefit from the intervention. The verification approach with feedback focuses on the lexical concept.

For word-verification, a participant was presented with a picture and a spoken word and the participant was asked to verify if the spoken word and the picture matched by saying *yes* or *no*. A similar word verification approach was used in the affix module but the target to be verified was the affixed word or/and phrase (e.g., *asked, man's arm*) instead of the word in isolation. Similarly, for sentence verification, a participant was presented with a picture and a spoken sentence and the participant was asked to verify if the spoken sentence and the picture matched or not by saying *yes* or *no*. The target stimuli were presented such that once the spoken word matched the picture and once it did not thus giving the patient the chance to say *yes* and *no* one time for every stimulus. The distractor words (e.g., *shred* for *ask*), affixes (*shredded* for *asked*) and sentences (*the woman shredded some paper* for *the woman asked the man a question*) used during verification were chosen from the list of trained verbs using random tables. The same distractor was used for each participant. Each participant was given corrective feedback by telling him/her if his/her response was correct or not and providing him/her with the target stimulus in question. The target stimulus in the corrective feedback served as a model. After the feedback, the participant was asked to produce the required target twice irrespective of whether the initial response was correct or incorrect. This production was imperative to control the number of times a person produced the target word or sentence and to make the number of productions consistent across participants. The person was prompted to say the target twice with the carrier phrase during the corrective feedback (e.g., *the word is…, the sentence is…*). During intervention, the action or the object in the word module was pointed with the mouse in the word module, the action (for verb affix) and parts of the noun phrase (e.g., *man's arm*, both man and arm) were pointed in the affix module and the parts of the sentence were pointed in the sentence module as the words were produced by the investigator. The main aim of using the mouse was to bring the participant's attention to the target and this served as a cue to the patient to produce the target word. No thematic roles or grammatical roles were specified during any of the modules of intervention.

In the affix module, it was important to use a noun phrase (e.g., *cow's face*) for nouns rather than just the noun+affix (e.g., *cow's*) because the target affix was the possessive affix that is used normally in a phrase. This use of noun phrase was unlike the affixed verb that was used for verbs (e.g., *asked*). Even though the overall phrase targeted is different, the process activated is the same i.e., affix retrieval. A combination of the lexical stem and the appropriate affix for that grammatical class relates to the affix and stem retrieval at the positional level in GEM for both verbs and nouns.

The order of presentation of the items during a session was randomised for every session to rule out an order effect. Six different orders for teaching the words in a session, correlating with six treatment sessions were chosen using random tables resulting in a different presentation order for every session e.g., session 1 had one order, session 2 had a different order and so on. The order in a particular session was the same for all participants.

Each session was approximately an hour long, consisted of intervention, baseline testing, and treatment and generalisation probes. Table 5.8 describes the detailed steps of intervention in the three different modules. The specific instructions in the three modules of intervention are listed in Appendix C.

Table 5.8 Steps of the experimental intervention for the three different modules of intervention.

Experimental intervention	
Word module (Verbs)	(Nouns)
Investigator presents a picture with a spoken word (e.g., *grate*)	Investigator presents a picture with a spoken word (e.g., *man*)
The participant verifies the word by saying *Yes/No*	The participant verifies the word by saying *Yes/No*
Investigator gives corrective feedback e.g., *Yes, that is correct, the word is ...*	Investigator gives corrective feedback e.g., *Yes, that is correct, the word is ...*
Investigator asks the participant to produce the target word twice	Investigator asks the participant to produce the target word twice
Affix module (Verb affix)	(Noun affix)
Investigator presents two pictures with a spoken word (e.g., *grated*)	Investigator presents a picture with a question followed by the answer (e.g., *Whose arm? Man's arm*)
The participant verifies the word by saying *Yes/No*	The participant verifies the answer by saying *Yes/No*
Investigator gives corrective feedback	Investigator gives corrective feedback
Investigator asks the participant to produce the target word twice	Investigator asks the participant to produce the target phrase twice
Sentence module (Verb sentence)	(Noun sentence)
Investigator presents two pictures with a spoken sentence (e.g., *the woman grated a carrot*)	Investigator presents a picture with a spoken sentence (e.g., *the man's arm is hurt*)
The participant verifies the sentence by saying *Yes/No*	The participant verifies the sentence by saying *Yes/No*
Investigator gives corrective feedback	Investigator gives corrective feedback
Investigator asks the participant to produce the target sentence twice	Investigator asks the participant to produce the target sentence twice

For P3 and P4, the presentation at the sentence level was modified. They were asked to repeat the sentence as with the other participants but due to their inability to repeat sentences as a whole, sentences were presented in words. Thus, they repeated the sentence word by word instead of repeating the complete sentence.

5.8.7.3 Scoring

The responses of the participants were scored taking into consideration the responses produced by normal controls. The subjects in the control group produced synonyms of the target word and these synonyms were called acceptable alternate words (e.g., *clean* for *wipe*, *cut* for *chop, delivery man* for *postman*). Semantic errors such as superordinates (e.g., the word *action* for the target verb) or associates (e.g., eraser for erase) were not acceptable alternatives.

Verbs: In the word module for verbs, responses of the participants included the target verb, acceptable alternate words (e.g., *clean* for *wipe*, *cut* for *chop*), production of nouns instead of verbs (e.g., *jigsaw* for *sorting money*), incorrect verbs (e.g., *partying* instead of *organizing a party*), production of the object instead of the target verb (e.g., *lamp* for *assemble*) and use of forms of do (e.g., *did, do*) instead of the target verb. Of these responses, only the target word or acceptable alternate word was scored as correct. In the affix module, the verb affix was scored correct only if the participant produced the appropriate affix along with the stem. If the participant produced only the stem, the response was scored as zero. During the affix module, a comparison was made between the production of verbs with affixes and verbs without affixes. These verbs produced without the affixes in the affix module were different from the verbs produced in isolation in the word module.

In the sentence module, scoring was considered based on the presence of obligatory arguments. Sentences were scored as correct only if they had all the clause elements for that particular sentence irrespective of the presence or absence of the affix. For example, a sentence such as *woman ask man a question* was scored correct in spite of the absence of an affix. However, if the participant produced *woman ask man*, the sentence was scored as incorrect. If the participant produced alternate nouns such as arbitrary proper nouns (e.g., *John, Mary*) or pronouns (e.g., *he, she*), the sentence was scored as correct. Verb sentences produced were scored in terms of clause elements. Sentences such as *I see he is fed* were scored as zero at sentence level and rescored as clause elements in terms of the number of subjects, verbs, objects and indirect objects produced. The stringent criterion for sentences whereby they were only scored as correct if all clause elements were present, was crucial to answer the research question of generalisation from production of verbs in isolation to production of the verb argument structure in sentences.

Nouns: For nouns, the responses of the participants included target nouns, acceptable alternate words (e.g., *delivery man* for *postman*), semantically related nouns (e.g., *fish* for *fisherman*), pronouns (e.g., *he*) and general nouns (e.g., *man*). Of these responses, only target nouns and acceptable alternate nouns were considered correct. In the affix module, the noun affix was scored correct only if the participant produced the appropriate affix along with the stem. If the participant produced only the stem, the response was scored as zero. During the affix module, a comparison was made between the production of nouns with affixes and nouns without affixes. These nouns produced without the affixes were different from the nouns produced in isolation in the word module.

For noun sentences, the two important components were the noun phrase and the complement. The noun phrase was a requisite for the sentence to be scored as correct. Noun sentences were scored as correct only if they had all the clause elements for that particular sentence irrespective of the presence or absence of the affix. In noun sentences, participants typically produced two kinds of sentences, one with the requisite phrase (e.g., *the man's arm is hurt*) and one without the requisite phrase (e.g., *the man is hurt*). Only the first type of sentence was scored correct. Though the sentence *the man is hurt* is grammatically correct, the intervention focused on the production of a sentence with a possessive affix and the production of a possessive affix required a noun phrase (e.g., *man arm*). Therefore, the production of sentences without the noun phrase was considered incorrect. Sentences with a noun phrase but without an affix were scored as correct (e.g., *man arm is hurt*). A different adjective from the target sentence was scored as correct provided it was meaningful in context of the picture (e.g., *the teacher's class is unruly* instead of *the* *teacher's class is active*). All empty utterances (e.g., *here we going to, we've come to*) and stereotypes (e.g., *here beside me*) were scored as zero.

5.8.7.4 Spontaneous speech sample

Spontaneous speech samples were obtained from every participant during baseline, after the word module, after the affix module and after the sentence module to compare the different samples and evaluate the effect of the intervention modules on spontaneous speech, if any. The generalisation effect will be assessed by evaluating an increase in the number of utterances produced and the number of verbs produced in the different categories of verbs (e.g., transitive, ditransitive). The verbs tell us indirectly about the types of sentences produced because a verb is categorised into a particular type based on the argument structure produced in relation to that verb. Additionally, spontaneous speech samples were obtained from a total of fourteen normal speakers. Six of these normal speakers served as control subjects in Study 1.

To elicit a sample, five different stimuli were used as proposed by Nicholas & Brookshire (1993). The different stimuli were a) cookie-theft picture from the BDAE, b) two pictures depicting different scenes of things going wrong when rescuing a cat and in a birthday party, and c) 2 picture sequences (six pictures that portray a short story) depicting an argument between a wife and a husband and an incident about a couple finding directions. The pictures used to elicit the speech sample are presented in Appendix E. The use of pictures made the content of speech produced relatively "predictable" (Yorkston & Beukelman, 1980, p. 29). The speech sample was recorded on audiotape using a portable tape recorder (Sony TCM 5000EV) with a built-in electret condenser microphone. The sample was transcribed using Computerised Profiling Corpus style format (CP, Long et al, 2002) and analysed using the Language Assessment, Remediation and Screening Procedure (LARSP, Crystal et al., 1976).

Justification: The aim was to use GCE in the current study because GCE is based on the performance of actual speakers. The procedures cited in the literature that use the GCE are LARSP and the Reading scheme (Edwards et al., 1993). Of these two procedures, LARSP was the one available at that point in time and was therefore used. The verb valency analysis, the verb-form analysis and the lexical analysis directly relate to the set of variables to be measured in the current study. These analyses yield relevant information about the relationship between lexical retrieval and sentence production. Information about the genitive inflection is gathered from the LARSP chart that lists the type and the number of inflections used. The language sample to be analysed consisted of the total utterances produced in response to the five pictures used to elicit the sample. This resulted in a difference in the length of the samples obtained from the participants. In the current study, utterances were used as a unit to segment speech samples both for the normal population and for patients with aphasia (see Appendix D, section D.4).

Reliability tests: The coding of speech samples was tested for inter-observer agreement and for reliability of scores obtained using LARSP. Ten percent of the coded speech samples were evaluated by a person proficient in LARSP to check for the percentage of agreement in coding the samples. The percentage agreement was calculated in terms of the individual codes for the utterances. For example, an utterance such as *the mother is washing the dishes* has codes at the clause level, the phrase level and the word level. The number of correct codes compared to the total codes required by a particular utterance as proposed by LARSP yielded the percentage agreement. There was an average percentage agreement of 94.54%. The lowest percentage agreement for an individual sample was 90.03%.

Speech samples from 14 normal speakers were used to check the reliability of the samples elicited using the five pictures among the participants. Test-retest reliability for the normal speakers would have required asking them to describe the same pictures on two different occasions. Unfortunately this was not carried out. However, an estimate of speaker reliability was obtained post-hoc for inter-speaker reliability using Cronbach's alpha and descriptive statistics, and for intra-speaker reliability using Cronbach's alpha. The five LARSP variables tested for reliability were total utterances, clausal complexity, syntactic complexity score, number of nouns and number of verbs. The variables were selected based on the research question of generalisation from experimental intervention to spontaneous speech (total utterances), the experimental intervention (number of verbs and nouns), and testing generalisation from verb retrieval to sentence production (clausal complexity and syntactic complexity score).

The reliability measures were estimated as follows:

a) Samples obtained from each picture were compared across the 14 normal speakers and reliability was tested using Cronbach's alpha (inter-speaker reliability.

b) Descriptive statistics such as mean, standard deviation and range were calculated for the samples obtained from the 14 normal speakers (inter-speaker reliability).

c) Samples within each speaker were compared. The responses to pictures 2 and 4 and also to pictures 3 and 5 were combined together for each speaker and values for the five variables were computed. Pictures 1-3 required descriptions of single pictures, while 4 and 5 required descriptions of series of pictures that told a story. Combining the descriptions of 2 with 4 and 3 with 5 gave two equivalent description tasks which were compared to estimate intra-speaker reliability.

Table 5.9 Cronbach alpha values for the different variables measured in LARSP.

Variable	**Cronbach's alpha Standardised (N = 14)**
Total utterances	0.89
Clausal complexity	0.72
Syntactic Complexity Score	0.59
No. of nouns	0.87
No. of verbs	0.84

The reliability test was performed post hoc. Cronbach's alpha values for the 14 samples are reported in Table 5.9 as an estimate of inter-speaker reliability. There is no agreed cut-off value for alpha. The higher the alpha is, the more reliable the test is. Usually 0.7 and above is acceptable (Nunnally, 1978). A low alpha indicates that the test in question may measure several attributes/dimensions rather than one.

The alpha values for four of the five variables for the fourteen normal speakers are within acceptable levels (i.e., above 0.7). The exception is the syntactic complexity score. The low level of alpha indicates that SCS may not be a reliable measure. The descriptive statistics that indicate inter-speaker variability and are also a measure of reliability are in Appendix F.

Intra-speaker reliability was tested using Cronbach's alpha. None of the variables from the two sets of pictures was significantly different. A lack of statistical significance indicated that the samples elicited using pictures 2 and 4 were not different from the samples elicited using pictures 3 and 5 in the normal speakers. Similar measures of reliability for the spontaneous speech samples from the participants were not performed because the number of participants was too low for the comparison to be reliable.

5.8.8 Order of intervention

The order of intervention was counterbalanced among the participants. There were two orders of intervention: Order 1 and Order 2. This order was repeated for the other four participants.

Table 5.10 outlines the two orders of intervention and the counterbalancing of order among the six participants.

Table 5.10 Order of intervention for the participants.

P1	P2	P3	P4	P5	P6
Order 1	Order 2	Order 1	Order 2	Order 2	Order 1

Order 1	Order 2
Verb-noun	Noun-verb
Verb affix-Noun affix	Noun affix-Verb affix
Verb sentence-Noun sentence	Noun sentence-Verb sentence

Session outline: A total of six sessions was chosen for treating every dependent variable based on calculations for the total time involved for one participant. The total number of sessions for all the variables for the pre-intervention battery, intervention, baseline, pre-intervention battery, post-intervention battery and maintenance was calculated and the total was 48. This intervention works out to be four months of intervention if a participant is seen three times a week. The sequence of presentation of different events is presented in Table 5.11.

A detailed outline for every session is provided for two of the participants, P1 and P2 who have a counterbalanced order in every behaviour in Table 5.12.

Table 5.11 Design of the study in terms of sessions.

Session	Event
1-3	Pre-intervention battery
4-8	Baseline + Spontaneous speech sample
9-20	Word module + Spontaneous speech sample
21-32	Affix module + Spontaneous speech sample
33-44	Sentence module + Spontaneous speech sample
45-47	Post-intervention battery
48	Maintenance

5.8.9 Maintenance probes

All the intervention stimuli were probed a month after the intervention to test for the maintenance of intervention. However, for participant 1, the maintenance probe was administered after ten days as she was not available at a later stage.

5.8.10 Generalisation measures

Generalisation measures were obtained by administering probes for the untrained stimuli for both verbs and nouns. Probes for verbs, verb affixes and verb sentences were obtained in one session followed by probes for nouns, noun affixes and noun sentences in the second session followed by verbs and verb forms in the

Table 5.12 Outline for different sessions for two participants with a proposed counterbalanced order for a total of 16 weeks. Pre-I (Pre-intervention), N (noun), V (verb), Post-I (post-intervention), P1 (participant 1), P2 (participant 2).

Week	Session	Module	P1	P2
1	1		Pre-I	Pre-I
	2		Pre-I	Pre-I
	3		baseline	baseline
2	4		baseline	baseline
	5		baseline	baseline
	6		baseline	baseline
3	7		baseline	baseline
	8	Word	N	V
	9		N	V
4	10		N	V
	11		N	V
	12		N	V
5	13		N	V
	14		V	N
	15		V	N
6	16		V	N
	17		V	N
	18		V	N
7	19		V	N
	20	Affix	N	V
	21		N	V
8	22		N	V
	23		N	V
	24		N	V
9	25		N	V
	26		V	N
	27		V	N
10	28		V	N
	29		V	N
	30		V	N
11	31		V	N
	32	Sentence	N	V
	33		N	V
12	34		N	V
	35		N	V
	36		N	V
13	37		N	V
	38		V	N
	39		V	N
14	40		V	N
	41		V	N
	42		V	N
15	43		V	N
	44		Withdrawal	Withdrawal
	45		Withdrawal	Withdrawal
16	46		Withdrawal, Post-I	Withdrawal, Post-I
	47		Post-I	Post-I
	48		Maintenance	Maintenance

third session and so on. This resulted in a probe for verbs and nouns in every alternate session. In the generalisation probe, the participants were asked to produce the target word, affix or the target sentence using the same procedure as in the baseline.

5.8.11 Control probe

A control probe was administered to every participant at baseline and after every module to rule out the effect of any extraneous variables other than the experimental intervention. Ten items from Test of Non verbal Intelligence (TONI; Brown, Johnsen & Sherbenou, 1997) were used. The selection of a nonverbal control probe was made taking into consideration the probable influence of a language intervention on a verbal probe. Additionally, as proposed by GEM, the lemma is not modality specific, i.e., the lemma activation is not restricted to a particular modality such as only oral or only written. Therefore, a verbal control probe may result in improvement in reading and writing. The control probe was not expected to improve.

5.8.12 Data analysis

The data analysis procedures for single-subject data and the pre-and post-intervention test data are described here.

Single subject data: Robey et al. (1999) recommend both visual analyses of single-subject data and statistical analyses. According to Robey et al. (1999), "visual analyses of single-subject data are necessary descriptive tools and statistical analyses are necessary inferential tools" (p. 466). Furthermore, a combination of visual analyses and statistical analyses capture clinical significance as well as statistical significance[6].

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[6] In the literature, one proposed method for testing statistical significance for single subject designs is the time series analysis (Crosbie et al., 1983; Robey et al., 1998) because it takes autocorrelation into account. Different types of time series analysis can be used such as interrupted time series analysis (ITSA) and improved ITSA called ITSACORR (Robey et al., 1998). However, for time series analysis, there is a need to have many data points (50-100) per phase. Similarly for ITSACORR, 10-20 scores per phase are needed for a better estimation of autocorrelation and power

Data points obtained using a single subject research design are inter-dependent. This correlation between a series of data points is called serial dependency (Portney & Watkins, 2000). That is, knowing the level of performance at one point in time allows the researcher to predict the value of subsequent points in the series. This serial dependency interferes with several statistical procedures and may be a problem for making inferences based on visual analysis (Portney & Watkins, p. 223).

Two different types of analysis were used for evaluating the single subject design graphs that were obtained for each participant: a) Visual analysis and b) Celeration line with binomial test.

Visual analysis involves analyzing the data in terms of within-phase and between-phase characteristics (Portney & Watkins, 2000, p. 217). Three characteristics of the data can be noted: level, trend and slope. *Level* refers to the magnitude of performance, *trend* refers to the direction of change within a phase and *slope* refers to the rate of change within the data.

A celeration line represents the linear trend and slope for a data series (Portney & Watkins, 2000, p. 220). The steps to draw a celeration line involve (Portney & Watkins, 2000, p. 222):

a) Count the number of data points in a particular phase and then divide these points into equal halves along the X-axis. A vertical line is drawn to separate the two halves (line a, see Figure 5.1).

b) Divide these halves into halves again using broken vertical lines (line b).

c) Determine the median score for each half of the phase by counting from the bottom up toward the top data point within each half phase.

d) A horizontal line (line c) is drawn through each median point until it intersects the broken vertical line (line b).

(Crosbie, 1993, p. 972). ITSA and ITSACORR were not possible for the current study because sufficient data points were not available.

e) Draw a straight line connecting the two points of intersection (line d).

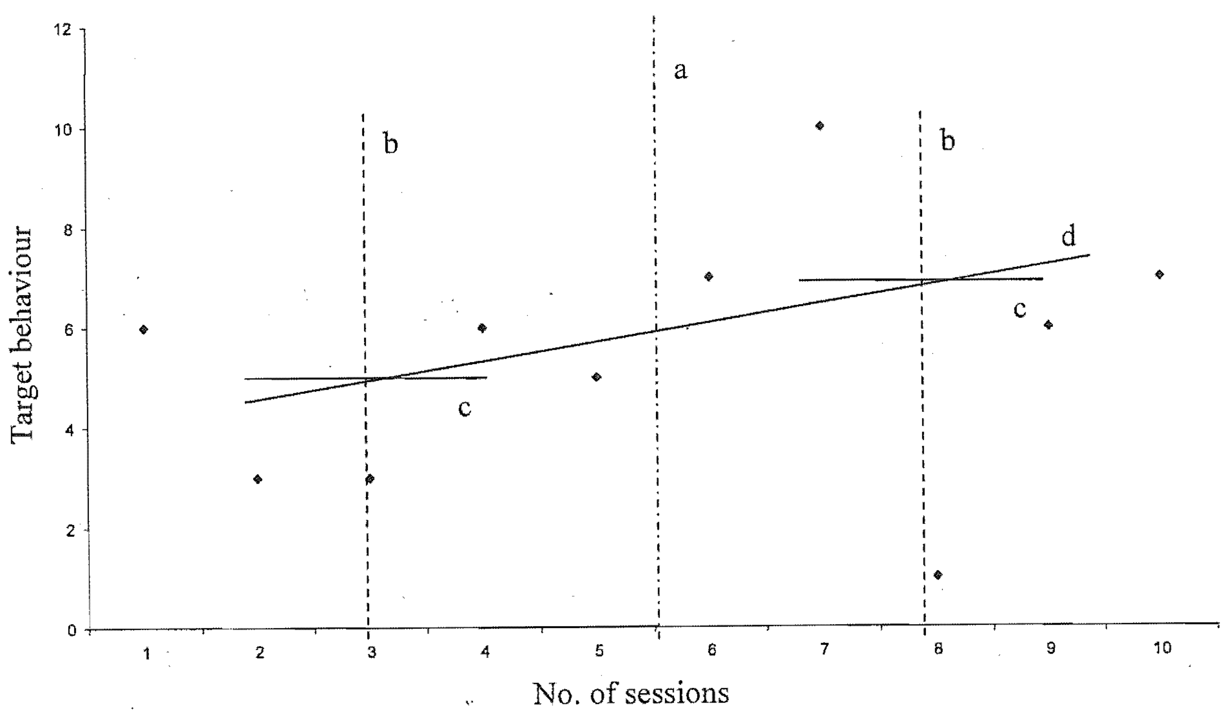

Figure 5.1 Explanation of the steps involved in drawing a Celeration line. This example involves the baseline phase.

A celeration line can be used to compare two adjacent phases. Statistical testing involved a comparison between two adjacent phases to see if the change in the production of that particular target was statistically significant or not. A binomial test is one of the methods used to test significance and to apply statistical inference to single-case data. A binomial test is used "when outcomes of a test can take one of two possible forms, in this case above or below the celeration line" (Portney & Watkins, 2000, p. 224). For example, a comparison between the baseline phase and the verb treatment phase would confirm if the improvement seen during the intervention was statistically significant. Thus, to compare the baseline and the intervention phase, a celeration line was drawn for the baseline phase. This was then extended into the intervention phase and some points in the intervention phase would fall below the extended celeration line and some would fall above the celeration line. The total number of points above and below the line and the fewer number of points above or below the line provided the values to test significance using the binomial test. Two values, n and x were used to determine the probability associated with the binomial test. The value n was the total number of points in the intervention phase and x was the fewer number of points above or below the celeration line (Portney & Watkins, 2000).

In Study 1, for most of the participants (except P1), the results were not statistically significant because some of the data points were on the celeration line. The points on the celeration line resulted in a lower number of data points than the value of n listed in the binomial table. For example, if more than two points fell on the celeration line, then the total number of data points was lower than the lowest value listed in the binomial test table. This resulted in a lack of statistical significance for the change seen in that particular participant.

Pre-and post-intervention data: Significance in the difference in the scores obtained on pre and post testing was tested using McNemar's test of statistical significance. The McNemar test is a "form of the chi-square statistic used with 2x2 tables that involve correlated samples, where subjects act as their own controls or where they are matched" (Portney & Watkins, 1999, p. 498).

5.9 Participants

A total of six participants were part of the study. All participants were adults with aphasia (age range 65-80; 4 women and 2 men) who had difficulty in producing a subject-verb-object sentence. All the participants had English as their first and primary language. Each of the participants were right handed and had aphasia caused by a single left-hemisphere stroke, ischaemic in nature that had occurred at least 6 months prior to the initiation of the study. The time post onset in these six participants ranged from 6 months to 72 months. Table 5.13 describes the personal characteristics of the participants.

Table 5.13 Personal characteristics of participants in the present study.

Participant number	Age	Sex	Education	Etiology	Months post onset
1	77	F	Registered nurse	Left MCA infarct	24 months
2	71	F	Primary	Left parietal lobe infarct	24 months
3	78	M	Primary	Left CVA	30 months
4	79	F	TTC*	Left CVA	48 months
5	83	F	Primary	Left CVA	6 months
6	76	M	Primary	Left MCA infarct	72 months

* Teachers training certificate

Participant 1 (P1) had mild to moderate apraxia as tested by the Apraxia Battery for Adults (ABA, Dabul, 1979). P5 had documented apraxia of speech (mild) and P6 had moderate to severe apraxia of speech. None of the participants had a documented history of a psychiatric disorder, dementia, mental retardation or severe dysarthria. Only P6 had severe apraxia. All the participants had received some form of speech-language treatment at the acute stage of their stroke. None of the participants were involved in any other treatment during the course of this study.

5.9.1 Normal subjects as control

For every participant in the study, a healthy person matched as closely as possible in terms of age, sex and education, without a history of any neurological deficit or dementia served as a control (see Table 5.14).

The tests administered to the control subjects included the Short form of BDAE (Goodglass, Kaplan and Barresi, 2001), the Verb Production Battery

(Thompson et al, n.d.) and the Sentence Comprehension Test (Thompson, Ballard and Tait, 1995) because norms were not available for these tests. Norms for the short form of BDAE were not accessible and norms for the other two tests do not exist. The scores for the control subjects were used to provide an indication of normal performance against which the results for the experimental participants were compared in these non-normed assessments. A speech sample was obtained for each control subject.

Table 5.14 Personal characteristics of control subjects for the six participants in the study.

Control subject	Age	Sex	Education
N1	80	F	Nursing certificate
N2	78	F	Primary
N3	82	M	Primary
N4	75	F	Nursing certificate
N5	85	F	Primary
N6	80	M	Primary

5.9.2 Classification of participants into categories

The main aim in this study was to evaluate the participants in terms of their ability to produce verbs and nouns before the intervention and explore the relationship between lexical retrieval and sentence production. Because of the discrepancy between the clinical impression and the standard test classification (e.g., Swindell et al., 1984), the participants were not selected based on BDAE.

During the pre-intervention battery, all the participants were administered the short version of BDAE. Table 5.15 lists the percentiles obtained for auditory comprehension and naming on BDAE and also includes the categorization of participants according to BDAE. The participants were classified post hoc. Another examiner who was not related to the study verified the classification profiles.

It was difficult to categorise the participants into one BDAE category as some of the participants had features of more than one classification category. For

Table 5.15 BDAE profiles for the six participants. Percentile range for both auditory comprehension and naming is listed.

	P1	P2	P3	P4	P5	P6
Percentile range	80-90	30	0	0-20	30-40	0
Aphasia (BDAE profile)	Broca's aphasia	Broca's like	Global aphasia	Wernicke's aphasia	Anomia	Global

example, P2 had features of Broca's aphasia but also had a poor comprehension in relation to the BDAE profile. Therefore, P2 was classified as 'Broca's like'.

5.10 Scores of participants

The six participants had a range of performance on the different tests of the pre-intervention test battery. The scores of the participants along with the mean and minimum scores for the control subjects are shown in Table 5.16. For BDAE, only those subtests that may be influenced by the intervention are presented in the table.

5.10.1 BDAE

Table 5.16 shows that participant 1 (P1) had better scores compared to the other five participants.

P1 had good auditory comprehension (90th percentile) with very good scores on naming (80th percentile). In spite of her good scores, her communication was mainly through fragmentary expression and her answers were mainly *yes* and *no*. She did not initiate a conversation though when asked to describe a picture, she was able to produce a couple of fragments. The BDAE indicated that P2 had a moderately affected auditory comprehension (30th percentile) with her repetition and naming affected (30th percentile). Her communication was mainly through one to two word phrases with a high production of stereotypes. The phrase that she repetitively produced was *here beside me*. P3 presented with a severely affected comprehension and production profile on the BDAE. Comparatively, his repetition

Table 5.16 Language test data for the six participants. Scores for BDAE are in percentiles. For Verb Production Battery, Sentence Comprehension Test and PALPA subtests, the scores presented are raw scores. P (participant) and N (control). Mean and the lower end of range values for control subjects are listed in the table. Number in brackets represents the total number of items in that particular subtest.

Test	P 1	P 2	P3	P4	P5	P6	N (control)	
							Mean	Min
Short form of BDAE								
Fluency	16	10	0	20	40	0	100	100
Conversational Speech	60	30	0	10	60	0	100	100
Auditory Comprehension	90	30	0	13	40	0	98.33	95
Repetition	40	30	30	0	35	20	80	80
Naming	80	30	0	0	30	0	99.17	95
Verb Production Battery								
Verb production (25)	16	2	0	0	10	1	23.67	22
Sentence production								
X (31, subject)	17	6	0	0	24	1	29.66	28
Y (21, direct object)	8	1	0	0	6	0	16	12
Z (7, indirect object)	1	0	0	0	0	0	3.83	3
V (31, verb)	25	14	0	0	12	0	28.83	26
Verb comprehension (25)	23	23	0	13	22	14	25	25
Sentence comprehension								
A (20, active)	11	9	2	4	11	11	16.83	13
P (20, passive)	10	11	2	4	13	9	17.83	16
SR (20, subject-relative)	14	9	0	2	10	12	18.16	15
OR (20, object-relative)	11	5	1	2	8	7	15.5	12
PALPA (Subtest 47 and 53)								
Spoken word-picture matching (40)[7]	40	37	2	27	38	14		
Spoken picture naming (40)[8]	36	9	0	0	15	1		

[7] Norms for Spoken word-picture matching in the normal population are N=40, M=39.29, SD=1.07

[8] Norms for Spoken picture naming in the normal population are N=40, M=39.80, SD=0.35

was preserved. P4 presented with some auditory comprehension (13th percentile) but poor naming and repetition. Auditory comprehension for P4 was good in everyday life that was evident while talking to her and was reported by her family but her speech output had large components of unintelligible speech. P5 had all the five measures on BDAE affected with percentiles in the range 30-60. P6 was able to score only on the repetition subtest of BDAE (20th percentile).

5.10.2 Verb Production Battery

P1 was able to produce the verbs 64% of the time and had a good comprehension of verbs (92%). The test of sentence production skills involved a written clue (for the verb) and she was able to produce subject and verb better than direct or indirect objects. For P2, verb production was poor (8%), in contrast to her comprehension (92%). In sentence production, she was able to produce mainly subjects (6/31) and verbs (14/31). P3 showed a no response on the Verb Production Battery. P4 showed that she had better comprehension of verbs (52%) compared to production (0%) of verbs and sentences on the Verb Production Battery. P5 had relatively poor verb production (40%) but good verb comprehension (88%). She was able to produce subjects more than any of the other verb arguments. P6 had a relatively preserved verb comprehension (56%) compared to verb production but was not able to produce any of the sentences. Chance performance for the verb comprehension subtest is a score of six (24%).

5.10.3 Sentence comprehension

Chance performance for the Sentence Comprehension Test is 50% (i.e., a score of ten) for each sentence category. The responses of the participants were about chance level or below chance level. P1 could comprehend subject-relative sentences (70%) but performed at chance level for the remaining sentences. P2, P5 and P6 performed at chance level.

5.10.4 PALPA subtests

Naming errors seen in the participants are summarized in Table 5.17. Scores on the PALPA subtests showed that P1 had a 100% comprehension for nouns and was able to produce 90% of the nouns (4 errors). P2 had good comprehension of nouns (92.5%) but a poor production of nouns (22.5%; 31 errors). The PALPA subtests indicated a poor comprehension and production of nouns for P3. P3's responses are below chance most probably because P3 did not try to answer all questions. P3's responses included close semantic distractors (e.g., *boot* for *shoe*), distant semantic distractors (e.g., *easel* for *paintbrush*), visually related distractors (e.g., *pipe* for *thumb*) and unrelated distractors (e.g., *rolling pin* for *pipe*) (see Table 5.17). P4 could comprehend nouns (27/40) better compared to production of nouns (0%). P5 had good comprehension for nouns but a poor production for nouns (25 errors) as indicated by the PALPA subtests. P6's comprehension was at chance (14/40) and he had correspondingly poor production (39 errors). A majority of P6's errors in word-picture matching were close semantic distractors (e.g., *baby* for *pram*, *coat* for *hat*) and a few were visually related distractors (e.g., *umbrella* for *parachute*).

5.10.5 Spontaneous speech

This section describes the characteristics of the speech samples obtained at the baseline for all participants. Table 5.18 shows the participants' response to the cookie theft picture.

P1 used fragments and certain relevant words to express herself. The spontaneous speech sample of P2 was predominated by stereotypes and single words out of context. P3 produced very few words such as *one* and *two*. P4 produced bursts of speech with intelligible words. P5 was able to produce most of the words but had trouble producing specific verbs and producing certain nouns. P6's speech consisted mainly of neologistic words and words out of context. From these samples, it is clear that all of the participants had severely impaired production of connected speech.

Table 5.17 Types of errors on PALPA subtests and their percentage. CSD (Close semantic distractor), DSD (Distant semantic distractor), VRD (visually related distractor), UD (unrelated distractor), NR (no response and responses such as cannot say, do not know).

Participant	Comprehension	Production
P1	No errors	Semantic (25%) Phonemic (75%)
P2	CSD (100%)	Semantic (16.12% Phonemic (6.45%) Unrelated (3.22%) NR (74.1%)
P3	CSD (5.2%) DSD (18.4%) VRD (13.1%) UD (23.6%) NR (39.4%)	NR (100%)
P4	CSD (61%) VRD (7.6%) DSD (7.6%) NR (2.3%)	Unrelated (100%)
P5	CSD (100%)	Semantic (12%) Phonemic (16%) Unrelated (4%) NR (68%)
P6	CSD (38%) DSD (19.2%) VRD (7.6%) UD (19.2%) NR (15.3%)	Unrelated paraphasias (100%)

Table 5.18 Responses of the participants to the cookie theft picture at baseline testing. The speech samples have been transcribed using CP transcription conventions. Utterances are separated by a period. '…' indicates a pause. All text enclosed in parantheses is treated as a maze.

Participant	Spontaneous speech at baseline
P1	cookie jar. (uh) wud (uh) clother clothe. yes. yes, wugi (uh) .
P2	and here beside. yes, hat and. here beside. (oh) but pull over the. here beside. and here beside. yes.
P3	one (two two) two. two.
P4	yes has zoz pin (wow) oizzi toswow. presses bells pesis. (shoul) has he should, (oops). (jodin) jodin. ajhi messel phosiz.
P5	Children are getting in a jar. And the mother is doing the…papers. The water is coming off the …of the. Kids are of the jar. Water…
P6	(water) water. figi (figi) . why? (why?) figi (figi). water.

The results for the participants in Study 1 will be described in Chapter 6.

6 Chapter Six: Results

The results of the participants will be discussed in this chapter. Before the presentation of the results of Study 1 (the main study), a brief section will explain the data points plotted in the figures.

6.1 Explanation of figures

For each intervention module, there were three phases: baseline, intervention and withdrawal. There were two categories of stimuli: trained and untrained. The trained stimuli received treatment and the untrained stimuli were probed to measure generalisation but were not treated. An individual session involved the intervention, a treatment probe for the items trained and generalisation probes (see chapter 5, section 5.8.7 and 5.8.10) for the untrained stimuli. We will take an example of one intervention module to explain the graphs for all the modules (see Figure 6.1). Figure 6.1 shows the effect of the experimental intervention on the verb modules in P1. In the baseline phase of the word module for verbs, the data points (plotted in the figure) represent the number of target verbs correctly produced before intervention. In the intervention phase, the data points represent the number of trained verbs produced in the treatment probe (i.e., produced spontaneously without a model or cue) in each intervention session. In the withdrawal phase, the data points represent the total number of trained verbs produced correctly in the absence of the experimental intervention. The total number of untrained items is 20 but they are depicted in the graph on a scale of 10 i.e., a data point of '2' corresponds to '4/20' correct.

The results for the six participants will be described under three main headings: experimental intervention, spontaneous speech and pre-and post intervention battery. A celeration line with a binomial test was used to evaluate the statistical significance unless otherwise stated. An analysis to determine the locus of impairment in GEM for all participants was done after the intervention in conjunction with the aim of the study. These analyses will be described after the intervention results (see chapter 7, section 7.4.1).

6.2 Experimental intervention

Following discussion of the control probe, the results will be described for the baseline, followed by the modules of intervention and maintenance probes of trained items. Changes in sentence structure after each module and reanalysis of scores is discussed to evaluate how the different modules affected sentence production. These will be followed by results for generalization probes. Results for only three of the six participants (i.e., P1, P2 and P5) are presented in detail here. Results for P3, P4 and P6 are not described because they showed minimal changes in response to the intervention.

Control probe: There was no improvement in the control probe in any of the participants. The lack of improvement in the control probe shows that the improvement seen in the trained stimuli is due to the experimental intervention and not a result of spontaneous recovery or a Hawthorne effect. A Hawthorne effect is a change in the outcome variable caused by the fact that the participants of the study know they are participating (Parsons, 1978). The data for the control probe are presented in Table G.1 in Appendix G. The data for the control probe are visually depicted in each participant's graph.

6.2.1 P1

6.2.1.1 Verbs

P1 had a variable baseline with a production of 2 (of a total of 10 verbs) verbs in isolation in the final baseline session. At affix level, P1 was able to produce 3 verb affixes[1] (see Figure 6.1). At sentence level, P1 was not able to produce any sentences. Instead of the complete sentence, P1 was able to produce only a verb (e.g., *lean*) or more than one clause element (e.g., *woman a ball*, *woman lean*).

Figure 6.1 depicts the change in performance for the three verb forms - trained verbs, verb affixes and verb sentences as a result of the experimental intervention in P1. Visually, Figure 6.1 shows that there is a change in level and there is a positive direction of change. To test for statistical significance, a comparison was made between the

[1] The term 'verb affix' as used in this thesis refers to the production of a verb with an affix (e.g., *asked, wiped*) and not to the affix in isolation (e.g., *-ed*).

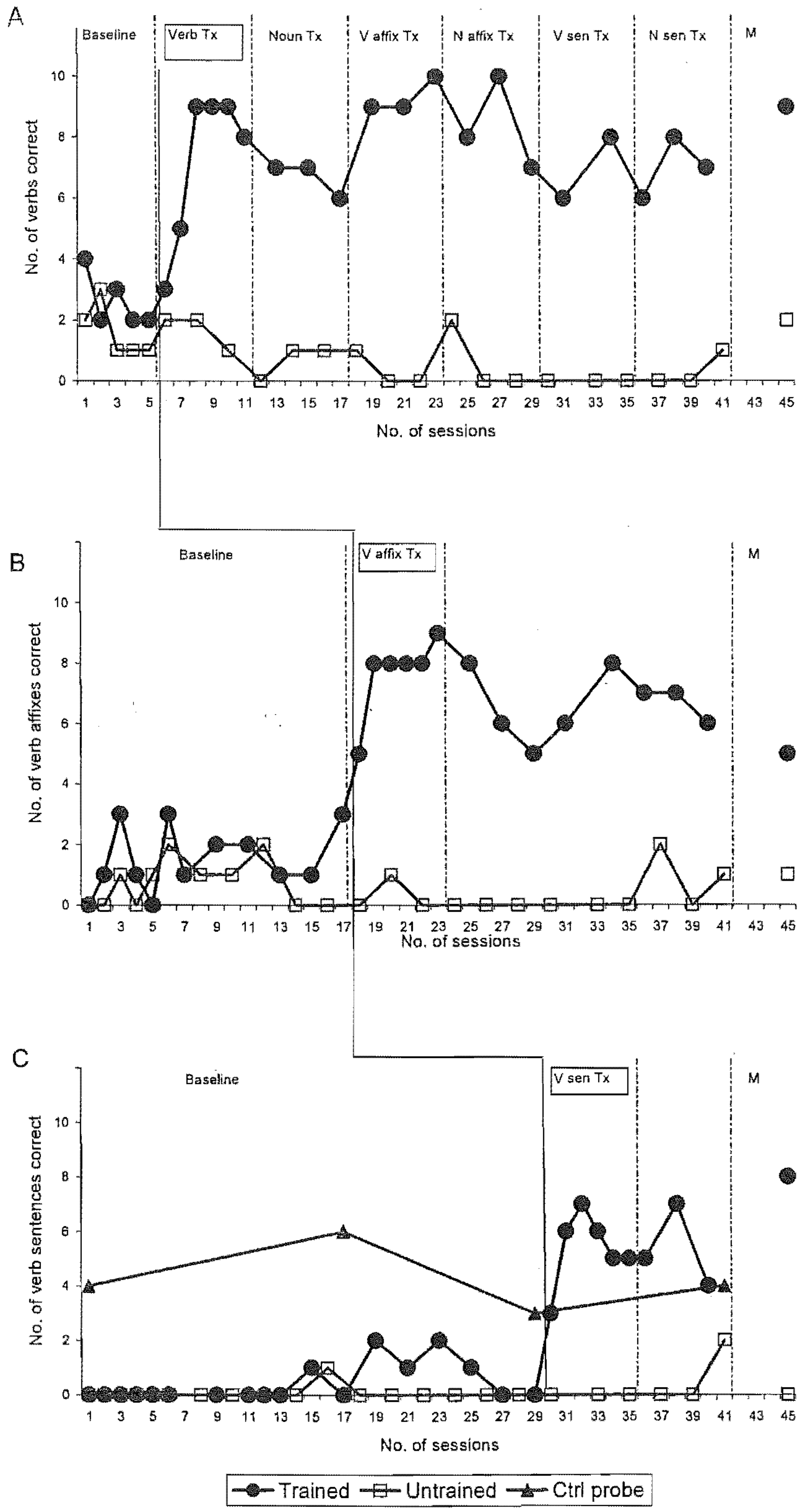

Figure 6.1. **P1**: Session-by-session data record for different verb-forms. The above figure shows the spontaneous production of verbs in isolation (A, session 6-11), verb affixes (B, session 18-23) and verb sentences (C, session 30-35) associated with the introduction of experimental intervention. The control probe is represented in panel C. Responses for the untrained nouns are scaled out of 10.

baseline phase and the verb treatment phase using a celeration line and a binomial test (see chapter 5, section 5.8.12). The improvement from the baseline performance to the change in spontaneous production of verbs, verb affixes and verb sentences in the treatment phase in all three modules was found to be statistically significant at $p<.05$ level. In contrast, untrained verb forms in word module, affix module and sentence module remained at baseline levels. The effect of intervention on trained verbs, verb affixes and verb sentences was maintained even after the intervention was withdrawn.

Maintenance: The number of target stimuli produced during the maintenance probe are reported and compared with the number of target stimuli produced in the last session of the intervention (i.e., session 40). For the verbs and verb-forms trained, P1 could produce more verbs in the word module than in the intervention (9 out of 10 in contrast to 7 out of 10 in the last session, session 40) (see Figure 6.1). Comparatively, verb affixes were maintained at a lower level (5 out of 10 in contrast to 6 out of 10 in the last session). In the sentence module, P1 was able to produce 8 out of 10 sentences in contrast to 4 in the last intervention session.

Affixes versus lexical stem: A comparison between the number of verbs produced with affixes and the total number of verbs produced (i.e., with and without affixes) was made in the affix module. For P1, there was a difference between the total number of verb affixes produced and the total number of verbs produced (Figure 6.2). The total number of verbs produced was higher than the verb affixes produced in the affix module. This difference between the number of verbs and verb affixes produced reduced during the verb affix treatment module (from session 18-23) and the overall gap reduced after the affix treatment module compared to the gap before the treatment module. No comparison was made for the untrained category because the participant did not show generalisation to the verb affixes in the untrained category.

Changes in sentence structure: At the baseline, P1 produced utterances such as *got, man, bottle of wine, finished.* After the word module, P1 produced one or two-word utterances such as *lean, choose, she ask, she fed* (i.e., verb in isolation or pronoun and the target verb). After the affix module, she produced sentences such as *Grandma fed him* (for *the woman fed him some yoghurt*), *woman leaned on* (for *the woman leaned crutches against the wall*). Sentences such as *Grandma fed him* were rescored as correct and as a result of the rescoring, P1'score changed from 2 sentences to 3 sentences after the affix module. The sentences produced were rescored as correct if they were relevant to the picture and if they were in context. After the sentence module, she produced correct sentences with all the arguments in place (e.g., *woman asked man a question*). In addition, she produced sentences such as *a woman stirred a lemon juice* (for *the woman squeezed a lemon*) and such sentences were rescored as correct. After rescoring, P1's score changed from 5 sentences to 8 sentences. Thus, sentence production improved after each module but P1 was able to produce a sentence with the complete argument structure only after the sentence module.

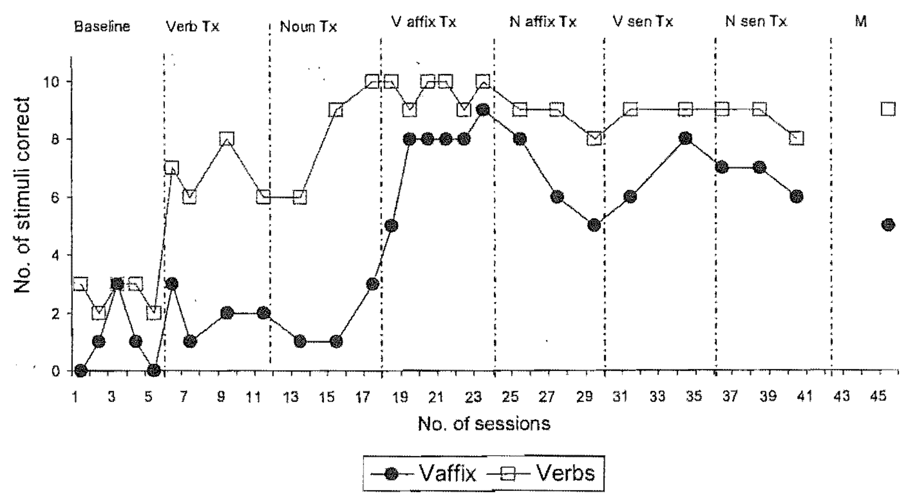

Figure 6.2. P1: Comparison between verb affixes and verbs produced in the affix module. This graph shows the production of verb affixes and the total number of verbs (irrespective of the affix) produced in the affix module for P1.

Reanalysing the responses: Sentences produced were reanalysed in terms of the clause elements produced to determine the verb arguments produced after each module. Quantification of the verb arguments produced would help in answering the question of generalization from different modules to sentence production. For verb sentences, a comparison was made between the verb sentences produced and the number of subjects,

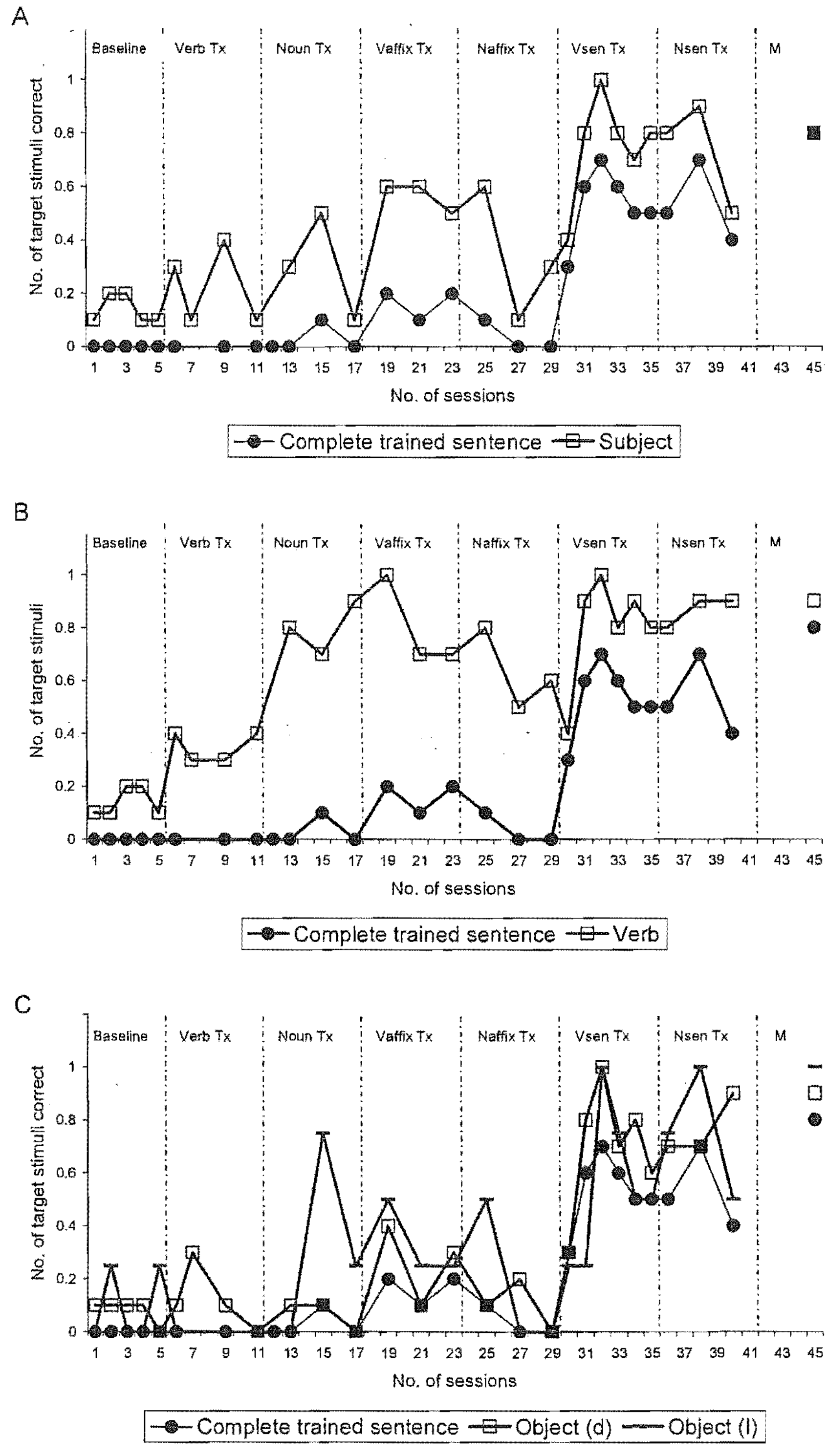

Figure 6.3. P1: Comparison of the number of trained sentences and the clause elements produced spontaneously at the sentence level. Panel A shows the comparison between sentences and the subjects produced, Panel B shows the comparison between sentences and the verbs produced and Panel C shows the comparison between sentences and the direct and indirect objects produced. Responses are in proportion correct.

verbs, direct objects and indirect objects produced when they were trying to say a sentence. In terms of clause elements, trained verb sentences had a total of 10 subjects, 10 verbs, 10 direct objects and 4 indirect objects. The untrained verb sentences had a total of 20 subjects, 20 verbs, 20 direct objects and 10 indirect objects. The untrained sentences were not analysed in terms of clause elements because the majority of the participants' responses were unrelated to the target sentences. Responses to untrained sentences are discussed below under generalisation.

For P1, we can see in Figure 6.3 that the participant was able to produce a greater number of subjects than the number of sentences (Panel A). Similarly, she is able to produce verbs in isolation but unable to form the same number of sentences (Panel B). The number of direct objects produced is more than the number of indirect objects (Panel C). A comparison between the number of clause elements produced and sentences produced shows that P1 produced the maximum number of clause elements in the sentence module resulting in a greater number of sentences produced.

Generalisation to untrained stimuli: P1 produced a few utterances for untrained verb sentences. At the baseline, P1 produced one-word utterances such as *she, peppers, party, letters* etc. instead of the target sentences. After the word module, her utterances were similar to the baseline responses except for a couple such as *pencil broken* (for *the woman broke a stick*), *tomato all and ready* (for *the woman chopped a pepper*). After the affix module, she produced one-word utterances and her production of one-word utterances was at a lower level than at the baseline. After the sentence module, her utterances were *woman, hung up* (for *the woman hung a jacket on the hook*), *woman jigsaw* (for *the woman sent her a letter*), and *Mum*. P1's responses show that she was able to produce the subject, the verb, or two word utterances but was unable to produce the argument structure of the target verbs.

Summary: P1 improved in her production of target verbs, verb affixes and verb sentences and this improvement was found to be statistically significant in the three intervention modules. There was no generalisation from training verbs in isolation to production of sentences. Only a minimal increase in the production of subjects and direct objects was seen during the word module. In contrast, she was able to produce part of the argument structure in response to few of the untrained sentences.

6.2.1.2 Nouns

P1 had a relatively high level of performance with four nouns in the final session of the baseline in the word module. P1 showed a variation in the production of noun affixes[2] (Figure 6.4). Before the start of the word module for nouns, P1 was able to produce 4-5 noun affixes approximately and the number of noun affixes produced after the word module increased to 7-9 approximately. P1 was able to produce two sentences at the baseline.

Figure 6.4 shows the effect of intervention on nouns, noun affixes and noun sentences in P1. Nouns in the word module changed from four in the final baseline probe to ten in the final treatment probe. Noun affixes showed variation – changed from 9 before the affix module to 8 in the final treatment probe. Noun sentences changed from 5 at baseline to 8 in the final treatment probe. While no significant improvement was found, P1 did produce slightly more trained items in each module.

The production of untrained nouns and noun sentences did not show a significant change after the intervention. The untrained nouns at word module changed from 10 (out of 20, depicted in Figure 6.4 as 5 out of 10) at the baseline to 13 (depicted as 6.5) in the final treatment probe. Surprisingly, the untrained noun affixes dropped from 15 (depicted as 7.5) before the affix module to 6 (depicted as 3) in the final treatment probe, though they were maintained at 12 (depicted as 6) after the intervention was discontinued. Untrained noun sentences changed from zero at the baseline to 3 (depicted as 1.5) in the final treatment probe.

Maintenance: For the nouns and noun forms trained, P1 showed maintenance for nouns in the word module (10 out of 10 in contrast to 8 in the last session) and noun affixes in the affix module (10 out of 10 in contrast to 9). The noun sentences in the sentence module (6 out of 10 in contrast to 8) were maintained at a lower level. Moreover, the untrained nouns showed good maintenance in the word module (11 out of 20 in contrast to 10), affix module (12 out of 20 in contrast to 15) and sentence module (3 out of 20 in contrast to 2) (see Figure 6.4).

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[2] The term 'noun affix' as used in this thesis refers to the production of a noun with an affix (e.g., *man's, chef's*) and not to the affix in isolation (e.g., *'s*).

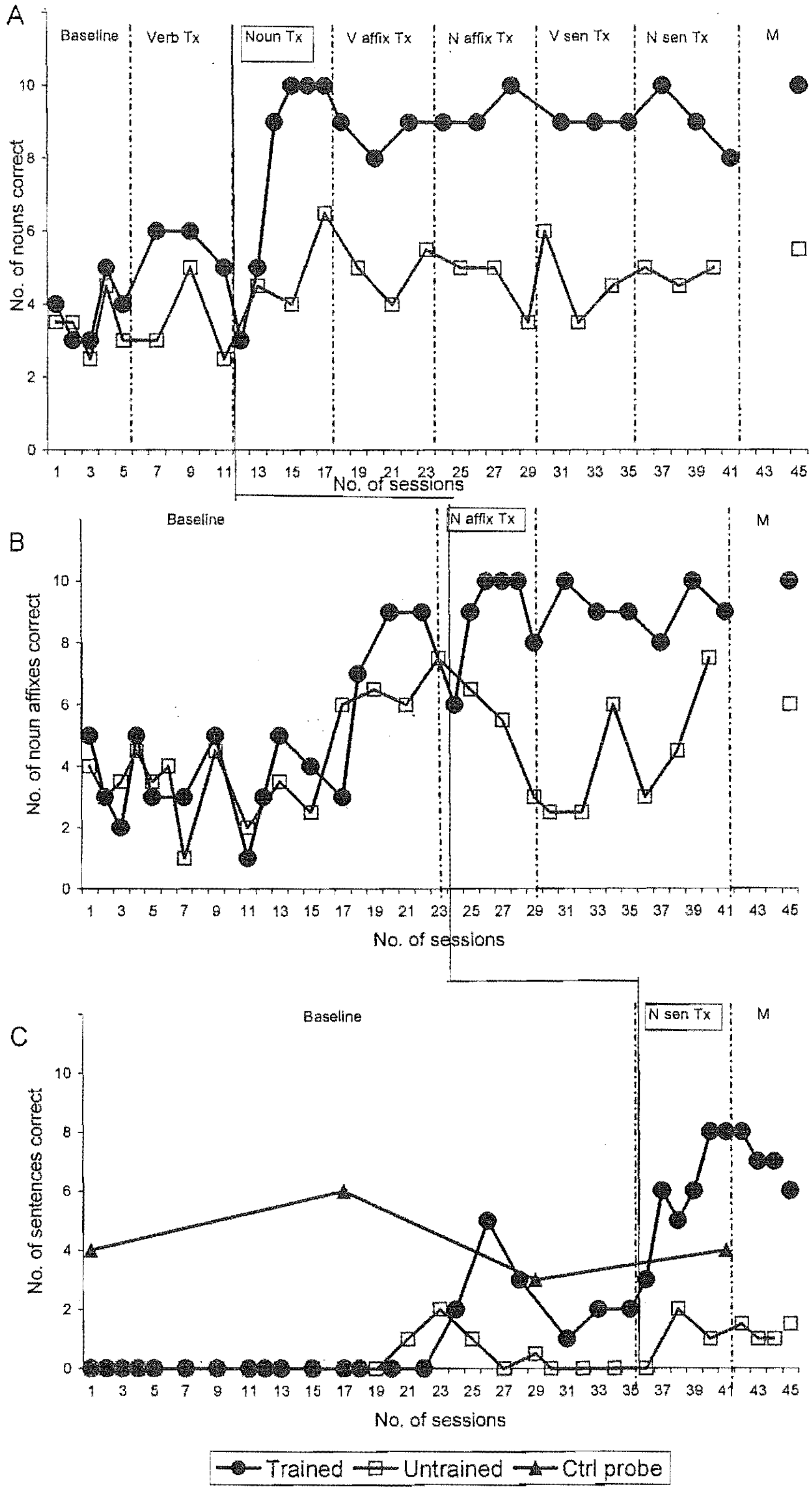

Figure 6.4. P1: Session-by-session data record for different noun-forms. The above figure shows the production of nouns in isolation (A, session 12-17), noun affixes (B, session 24-29) and noun sentences (C, session 36-41) associated with the introduction of experimental intervention. Responses for the untrained nouns are scaled out of 10.

Affixes versus lexical stem: The participants were expected to produce nouns with affixes in the affix module but some of the participants produced the target nouns without affixes. A comparison between the number of nouns produced with affixes and the total number of nouns produced was made in the affix module.

For noun affixes, a comparison was made both for noun affixes in the trained category and in the untrained category. For both the trained and untrained categories, the difference in the spontaneous production of noun affixes and nouns was minimal in P1 (Figures 6.5 A & B).

Changes in sentence structure: At the baseline, P1 produced utterances such as *man, chef, give, man's dress*. After the word module, she produced some syntactically correct but semantically incorrect sentences such as *cobbler is very full, donkey's ear is very full*. Such sentences were not rescored as correct. After the affix module sentences were shorter but more meaningful such as *donkey's ears heavy, complicated ladder*. After the sentence module, majority of her sentences were target sentences. Rescoring of sentences did not result in a change in score after any of the modules.

Reanalysing the responses: The noun sentences were reanalysed in terms of the clause elements produced. A comparison was made between the noun sentences produced and the number of nouns, copulas and complements produced. In terms of clause elements, trained noun sentences had a total of 10 subjects, 10 copulas and 10 complements. Similarly, untrained noun sentences had 20 each of subjects, copulas and complements.

For P1, a comparison between the nouns sentences produced and the clause elements produced at sentence level for the trained category indicated that the improvement in the spontaneous production of noun sentences was gradual with a relatively greater number of subjects produced throughout the entire experimental intervention (Figure 6.6). The production of subjects showed an increase and a decrease

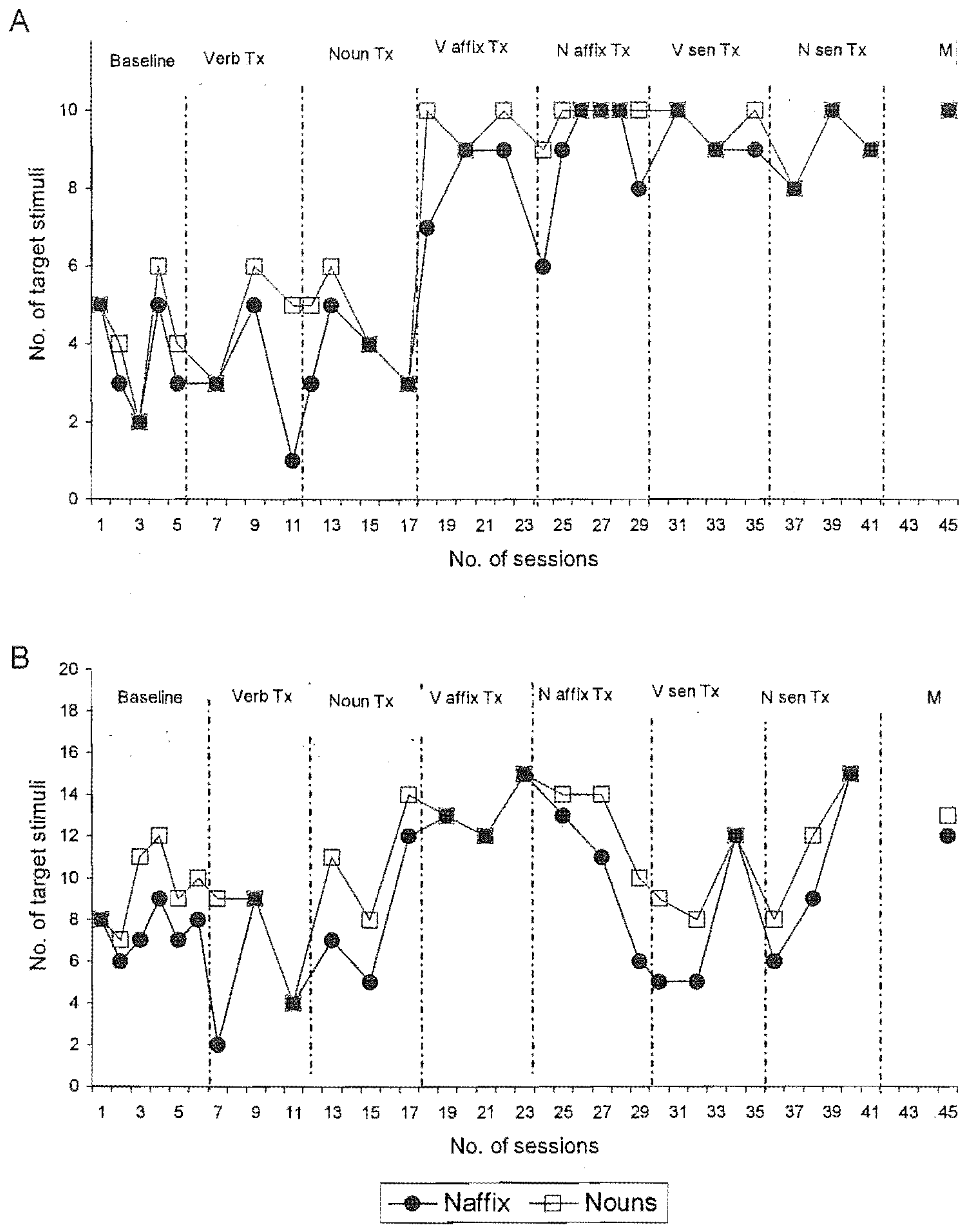

Figure 6.5. P1: Comparison between noun affixes and nouns produced at affix level. Panel A shows the comparison for the trained category and panel B shows the comparison for the untrained category.

in certain phases of the intervention. A change in the production of subjects correlated with the intervention modules for nouns, verb affixes, noun affixes and noun sentences though there was a certain reduction towards the end of the noun affix module. Copulas and complements showed a change during the affix modules (Panel B) and during noun sentence module (Panel C).

For the untrained category, the number of noun sentences produced was low though there was a change in the number of subjects produced throughout the entire experimental intervention (Figure 6.7, Panel A). The untrained noun sentences showed a small change in the spontaneous production (from zero to a maximum of 4 out of 20) for P1. The number of verbs (copula) produced varied and increased during the noun affix intervention phase (from 24-29) and during the noun sentence intervention phase (from 36-41) (Panels B and C). The maximum number of complements was produced during the verb affix module. There was a variation in the production of the various clause elements such as subject, verb and complement though a relatively higher number of subjects was produced in comparison to the verbs and complements produced (Figure 6.7).

Generalisation to untrained stimuli: Generalisation to untrained nouns and untrained noun affixes was not seen in P1 (see Figure 6.7). At the baseline, P1 produced utterances such as *mouth, catch, lion mane, mane's*. P1 After the word module, P1 produced utterances such as *man's machine is empty, man's truck*. After the affix module, sentences were similar to ones produced during the word module (e.g., *man's heavy work, man's coat heavy*). After the sentence module, P1 produced utterances such as *monkey's tail is heavy, fisherman's catch is heavy*. P1 had a tendency to use the same adjective for majority of the sentences.

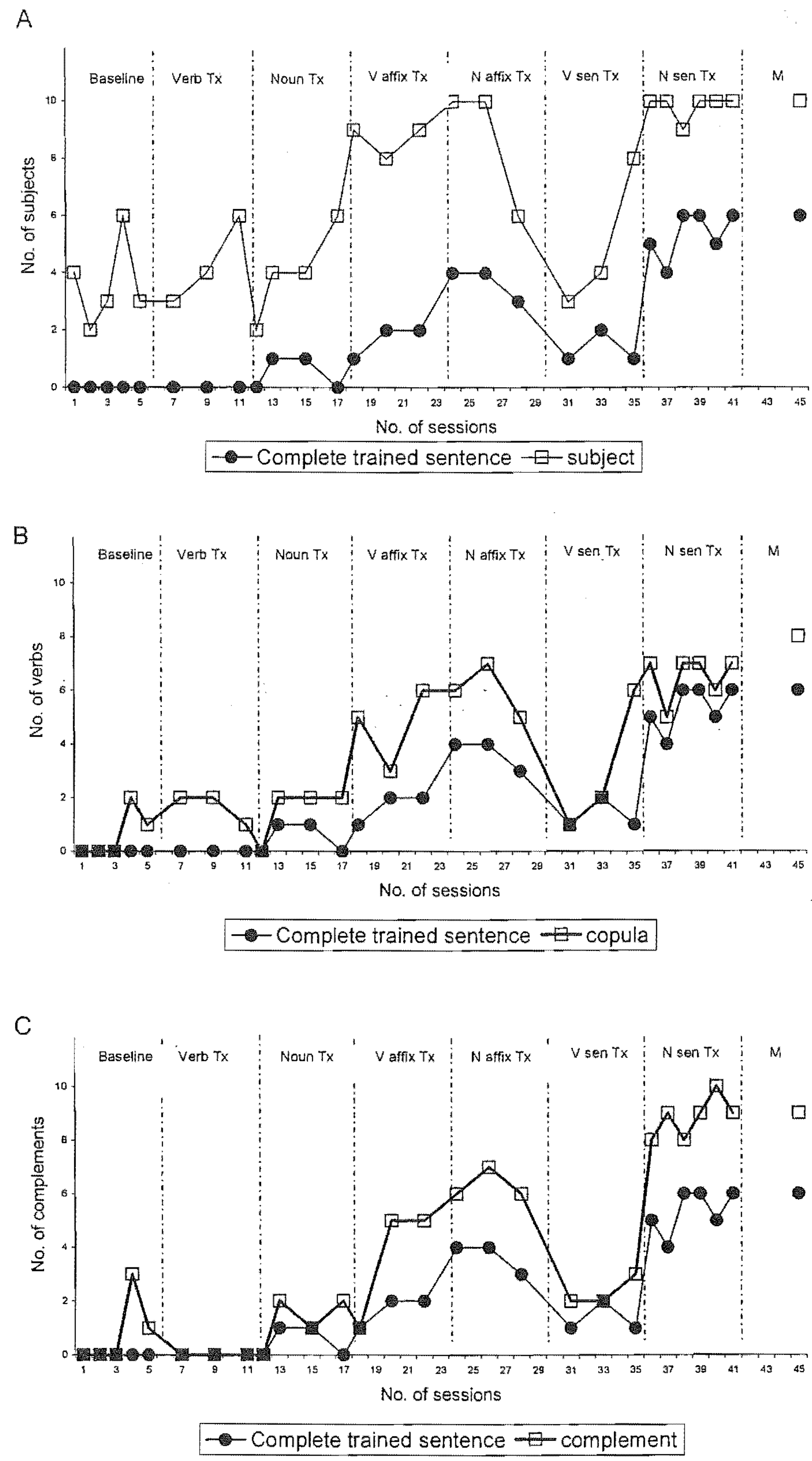

Figure 6.6. P1: Comparison of noun sentences and clause elements produced at sentence level. Panel A shows the comparison for complete trained sentences and subjects, panel B shows the comparison for complete trained sentences and copulas, panel C shows the comparison for complete trained sentences and complements.

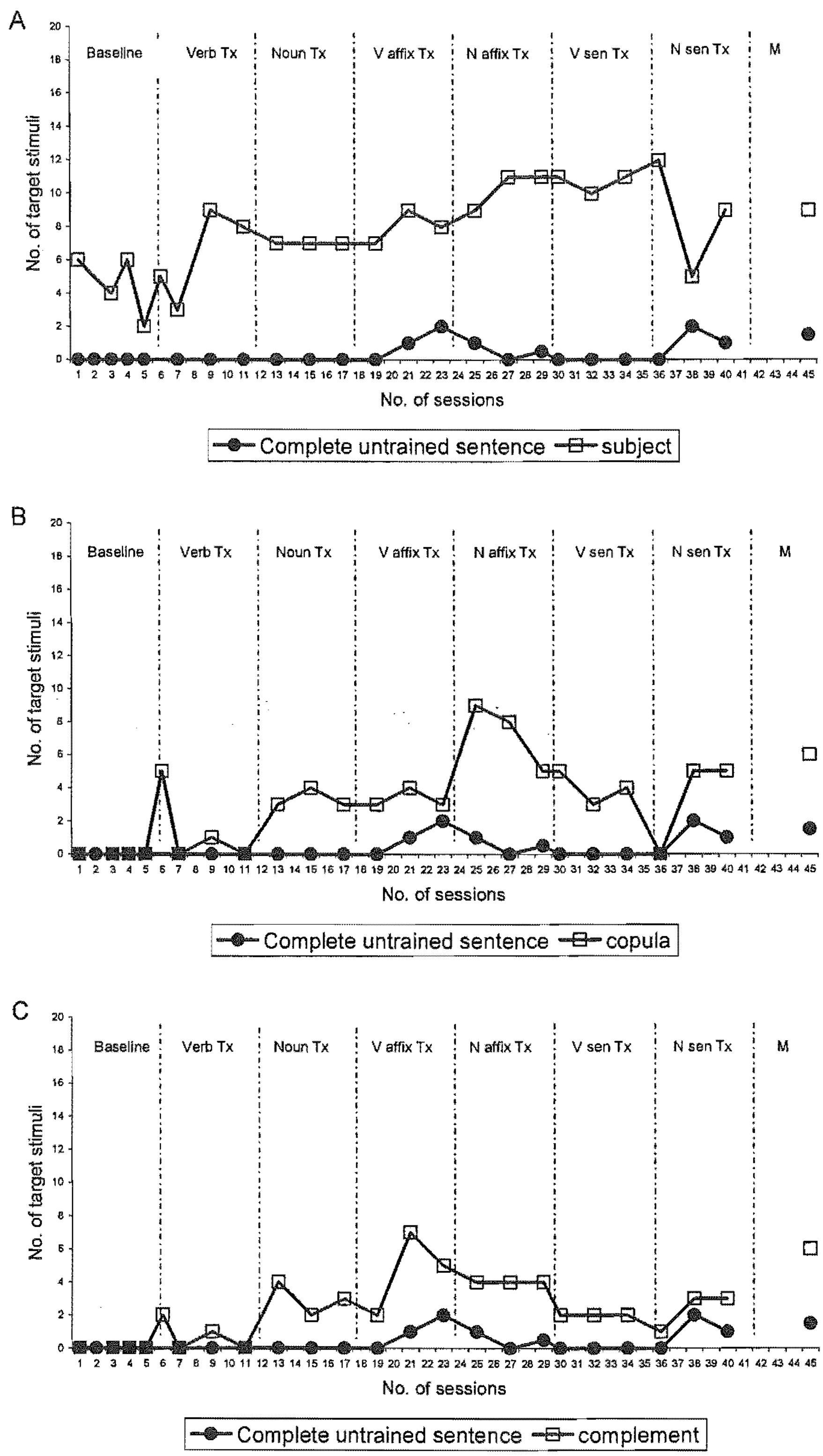

Figure 6.7. P1: Comparison of untrained noun sentences and clause elements produced at sentence level. Panel A shows the comparison for complete untrained sentences and subjects, panel B shows the comparison for complete untrained sentences and copulas, panel C shows the comparison for untrained sentences and complements.

Summary (noun modules): P1 did not show significant changes in the production of trained and untrained stimuli in the intervention modules. P1's responses indicate that she was able to retrieve the sentence structure but her choice of adjectives was not correct.

6.2.2 P2

6.2.2.1 Verbs

P2 was able to produce only one verb at the baseline. P2 was not able to produce any verb affixes or verb sentences (see Figure 6.8).

Figure 6.8 shows the effect of experimental intervention on trained verbs, verb affixes and verb sentences for P2. Visually, the verbs in the word module changed from a final baseline performance of one to five verbs in the final treatment probe. However, on comparison of the performance in baseline phase with that in the intervention phase, the change in production was not found to be statistically significant using the celeration line and the binomial test. The verb affixes in the affix module changed from a zero to six in the final treatment probe. Verb sentences changed from zero to five in the last treatment session. However, these changes in production of verb affixes and verb sentences were not found to be statistically significant.

Maintenance: P2 showed a lower level of maintenance in the word module and affix module (range 2-3 out of 10) in contrast to five in the word module and two in the affix module in the last sessions but no maintenance was seen in the sentence module (see Figure 6.8).

Affixes versus lexical stem: For P2, the production of verb affixes matched closely to the total number of verbs produced until session 31. The production differed remarkably in session 31 (one verb affix versus seven verbs). This drop in the production of verb affixes can be related to the cessation of verb affix treatment module in session 29. This was the first probe session after the affix module and we can see in the graph that there is a reduction in the overall production of verbs after this session (see Figure 6.9).

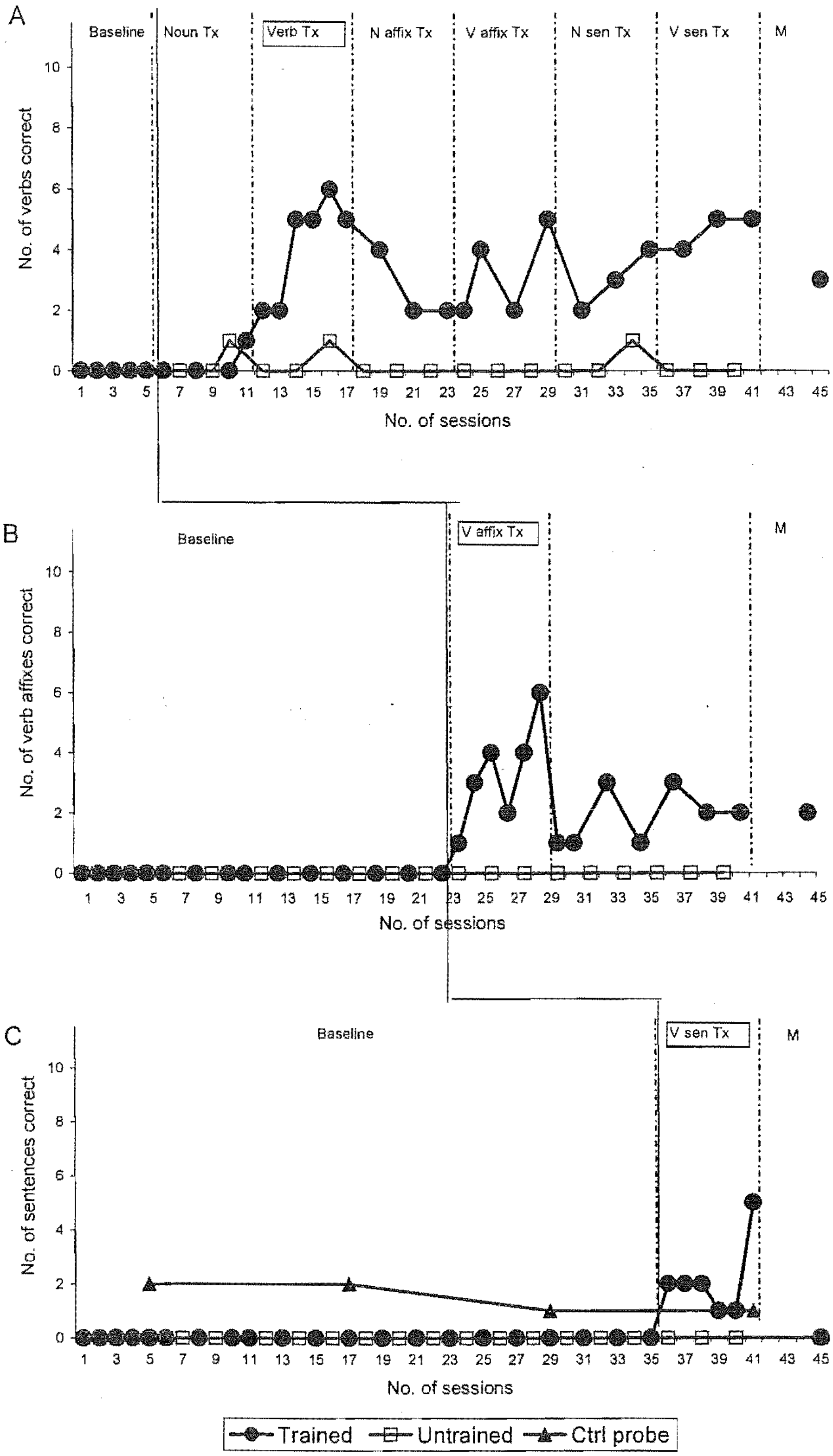

Figure 6.8. P2: Session-by-session data record for different verb-forms. The above figure shows the production of verbs in isolation (A, session 12-17), verb affixes (B, session 24-29) and verb sentences (C, session 36-41) associated with the introduction of experimental intervention. Responses for the untrained nouns are scaled out of 10.

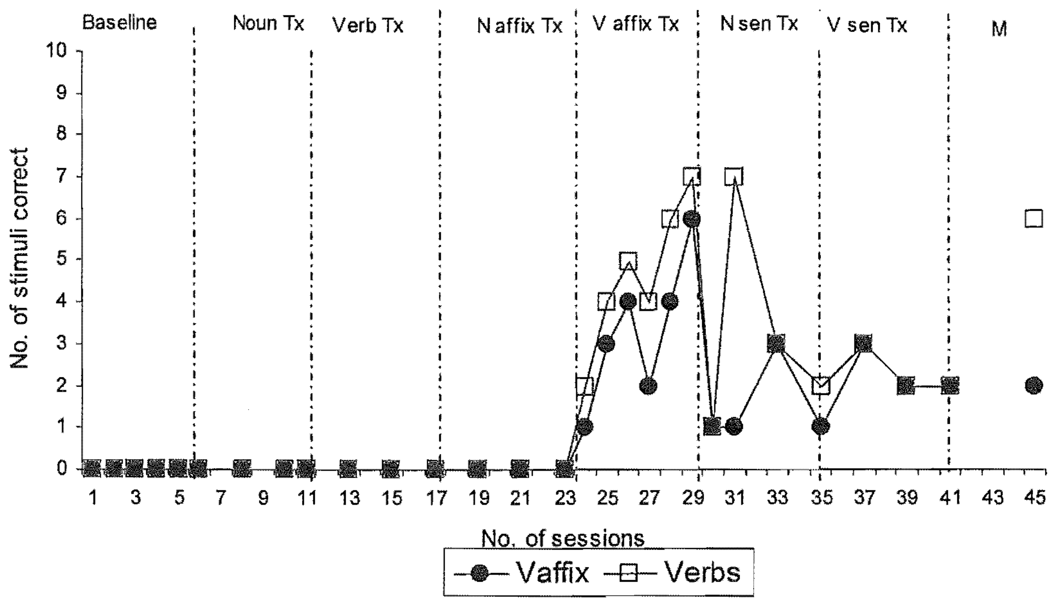

Figure 6.9 P2: Comparison between verb affixes and verbs produced at affix level. This graph shows the spontaneous production of verb affixes and the total number of verbs (irrespective of the affix) produced at affix level for P2.

Changes in sentence structure: P2 responded with one word utterances such as *no, jump, ball* for some of the items at the baseline. Her responses remained the same after the word module. After the affix module, her responses changed to target verbs such as *shredded, squeeze* and utterances such as *the little boy and girl, man and girl.* After the sentence module, she produced utterances such as *lady asked man, lady shred it.* She was able to produce target sentences for some of the verbs. The sentence structure is evident after the sentence module as seen in P1. Rescoring of sentences did not result in a change in score.

Reanalysing the responses: For P2, the maximum activity for the production of verb sentences was seen only during the sentence module and a remarkable increase in the various clause elements was seen after the start of the intervention at the sentence module (Figure 6.10). The production of verb sentences was zero until the start of the intervention for sentences i.e. session 36. Before the sentence module, P2 produced the verb in isolation for two verbs (e.g., *squeezed*) and one of the verb arguments (*ball* for *the woman threw the ball to the boy*). Though the number of sentences produced by P2 is

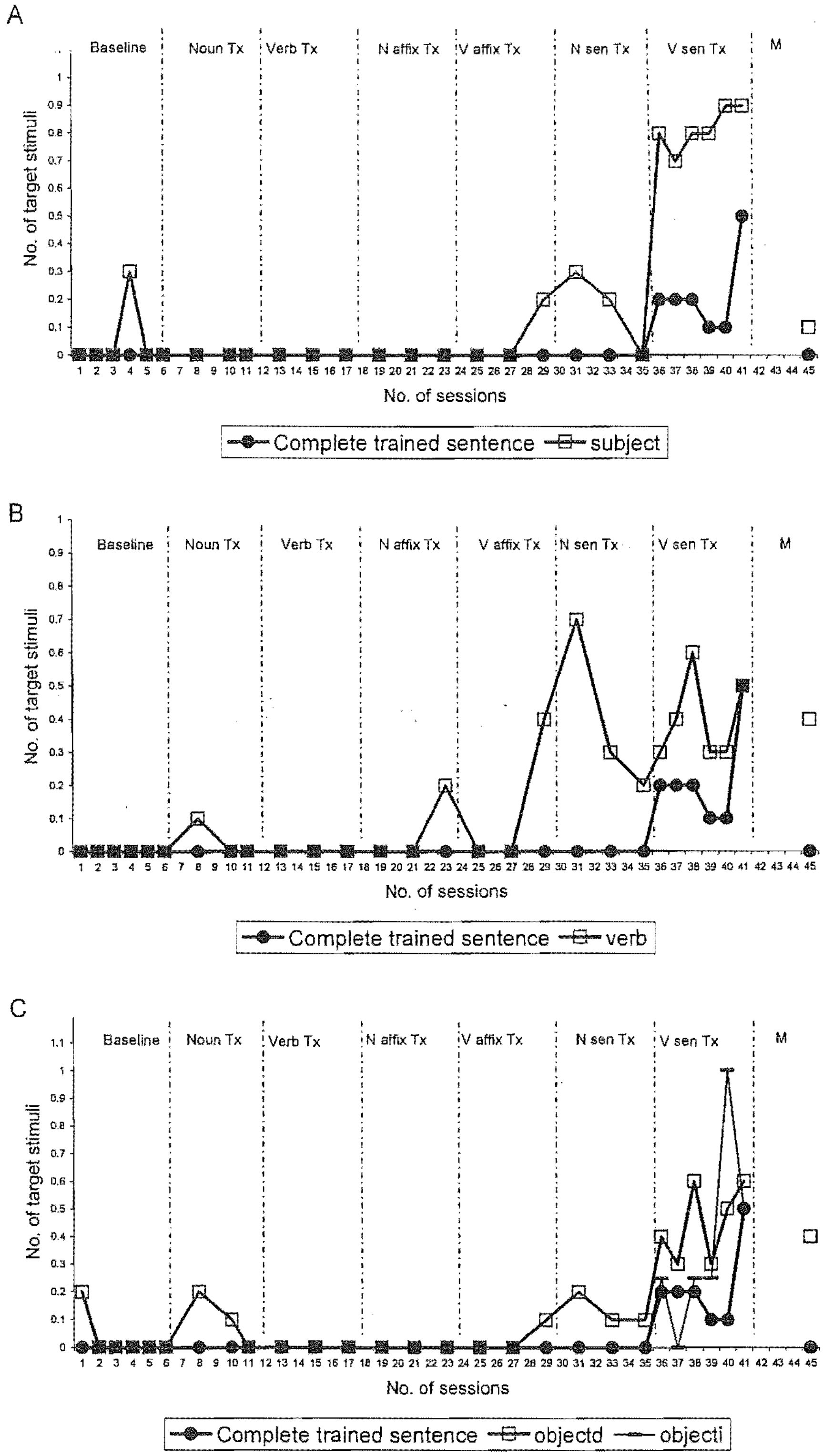

Figure 6.10. P2: Comparison of the number of trained sentences and the clause elements produced spontaneously at the sentence level. Panel A shows the comparison between sentences and subjects produced, Panel B shows the comparison between sentences and verbs produced, and Panel C shows the comparison between sentences produced and direct and indirect objects produced. Responses are in proportion correct.

low, there is an increase in the production of subjects (Panel A), verbs (Panel B) and direct and indirect objects (Panel C).

Generalisation to untrained stimuli: Untrained verb forms at the word module, the affix module and the sentence module remained at baseline levels. P2 produced stereotypes such as *here beside me*, *yes and no* at the baseline. Other utterances were mainly one-word such as *shirt* (for *the woman hung a jacket on the hook*) and *a boy and a girl* (for *the woman organised a party for the boy*). After the word module, her responses were similar. After the affix module, P2 produced similar one-word utterances such as *postman*, *cup of tea* and stereotypes. After the sentence module, P2 was able to produce only nouns related to the picture but was unable to produce the verbs related to the untrained sentences (e.g., *woman, lamp*).

Summary: P2 showed no statistically significant changes in the production of verbs in isolation, verb affixes and verb sentences. Despite her poor production of verbs at baseline, she was able to produce verb sentences for some verbs after the intervention. There was no generalization from verbs in isolation to production of sentences. She was not able to produce a similar structure for untrained verb sentences.

6.2.2.2 Nouns

The results for P2 for nouns and noun forms are shown in Figure 6.11. P2 was able to produce one of the nouns and noun forms during the baseline at the three linguistic levels. The change in nouns in the three different modules was found to be statistically significant using McNemar's test. Nouns at word module improved from one at the baseline to seven in the final treatment probe in the word module ($p = .031$, 1-tailed). Noun affixes improved from one at baseline to eight in the final treatment probe ($p = .031$, 1-tailed). Noun sentences improved from one in the final baseline probe to nine sentences in the final treatment probe ($p = .004$, 1-tailed). There was no change in the untrained nouns and noun forms as a result of the intervention.

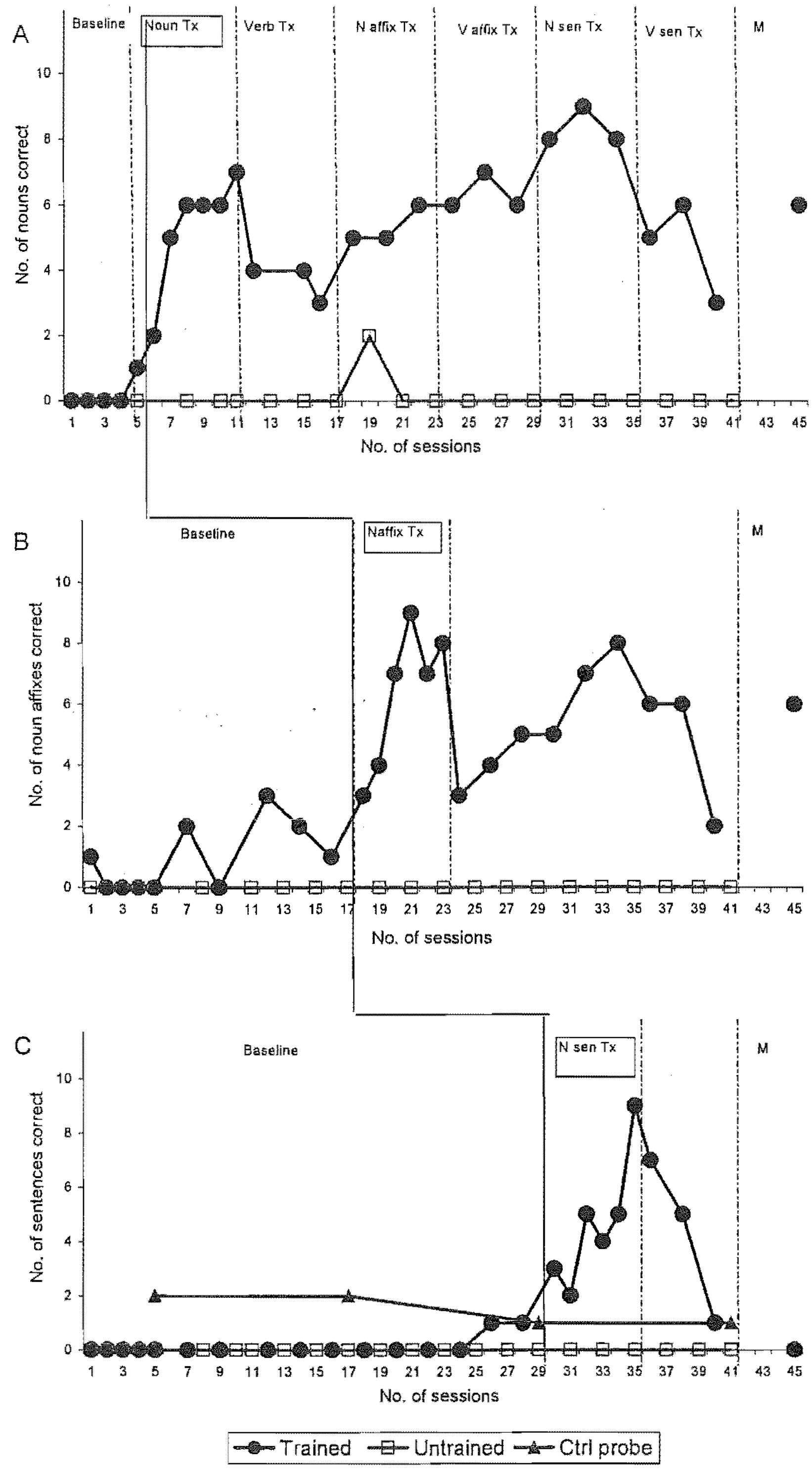

Figure 6.11. **P2**: Session-by-session data record for different noun-forms. The above figure shows the production of nouns in isolation (A, session 6-11), noun affixes (B, session 18-23) and noun sentences (C, session 30-35) associated with the introduction of experimental intervention. Responses for the untrained nouns are scaled out of 10.

Maintenance: P2 showed maintenance in the word module (6 out of 10 in contrast to 3) and affix module (6 out of 10 in contrast to 2) but no maintenance in the sentence module (Figure 6.11).

Affixes versus lexical stem: As shown in Figure 6.12, the production of noun affixes for P2 matched very closely to the production of nouns.

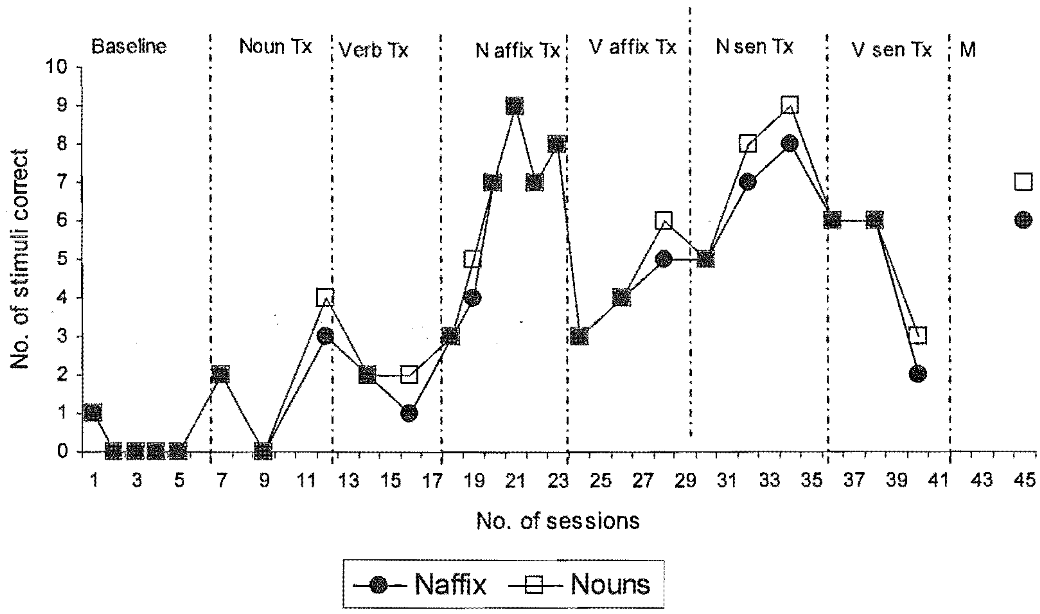

Figure 6.12. P2: Comparison between the production of affixes and the lexical stem at the affix module.

Changes in sentence structure: P2 produced single word responses for some of the nouns (e.g., *sheep, donkey, no*). Her responses were similar after the word module. After the affix module, her responses included parts of the noun phrase such as *cow and face, ladder and engine, donkey's face*. For P2, sentences during the baseline consisted of stereotypes such as *here beside me*, empty sentences not relevant to the picture like *here we going to, we've come to* and some nouns related to the picture (e.g., *boot* for *the cobbler's shop is messy*). After the sentence module, she was able to produce majority of the sentences. Rescoring of sentences did not result in a change in score.

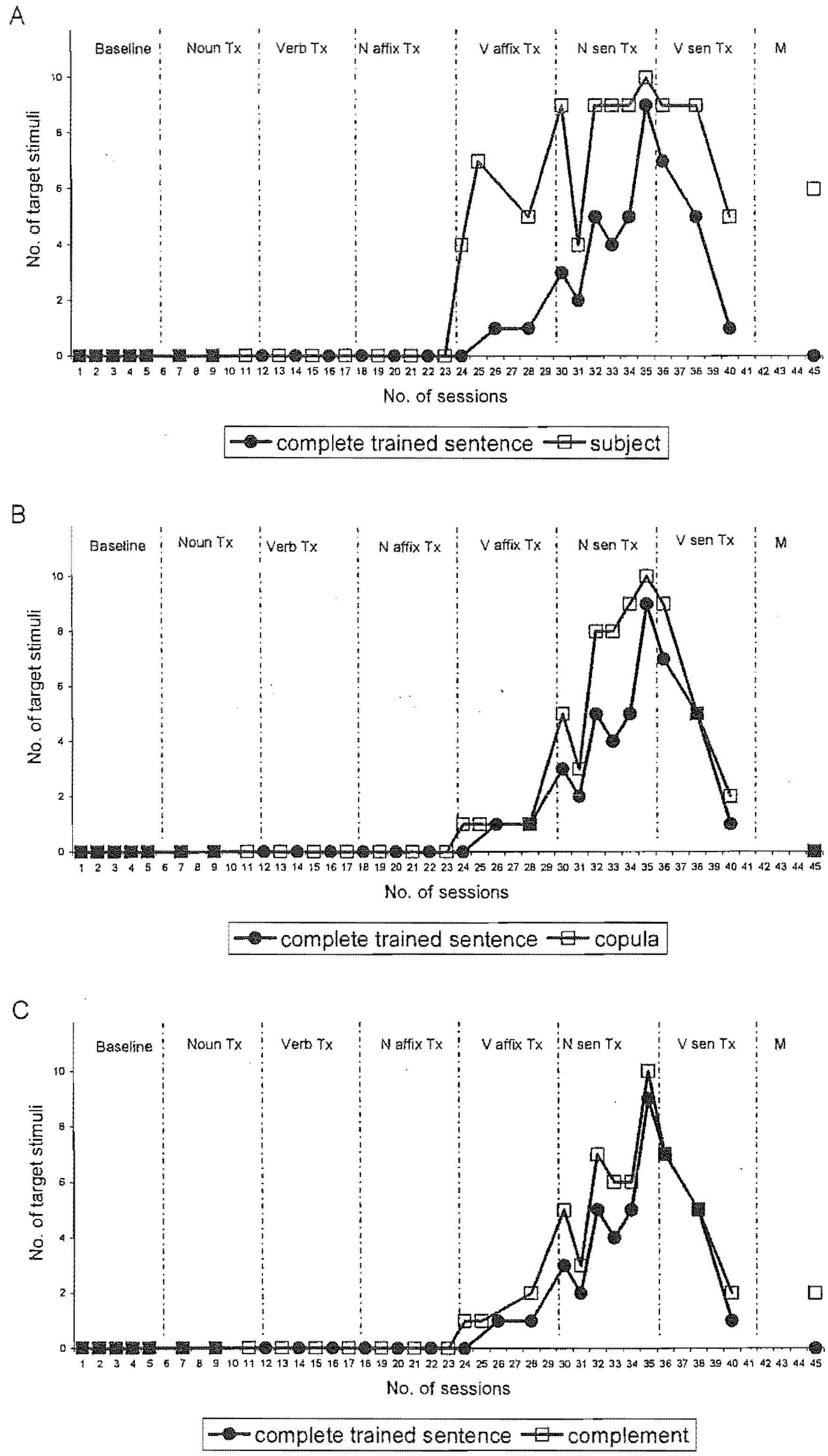

Figure 6.13. P2: Comparison of noun sentences and clause elements produced at sentence level. Panel A shows the comparison between sentences produced and the nouns produced, Panel B shows the comparison between sentences and verbs produced, and Panel C compares sentences and complements produced.

Reanalysing the responses: For P2, the comparison between noun sentences and clause elements produced at sentence level indicated that the number of subjects produced was greater than the number of noun sentences produced (Figure 6.13). Noun sentences reached a high level of nine (out of ten) noun sentences and the copulas produced and the complements produced followed a similar trend (Figure 6.13, panels B and C). For P2, a comparison was not made for untrained sentences because she produced stereotypes and one word utterances not related to the target.

Generalisation to untrained stimuli: The untrained nouns changed minimally for P2 (see Figure 6.11). P2 initially produced incorrect one word utterances (not related to the target) (e.g., *jacket, wood*) and stereotypes such as *here beside*. Her responses were similar after the word module and included some words related to the target noun (e.g., *pen* (for secretary), *hat and coat*). Her responses remained the same after the affix module and the sentence module.

Summary: P2 showed a statistically significant increase in the production of nouns, noun affixes and noun sentences. A maximum increase in the production of clause elements was seen during the sentence module. She showed a poor response to untrained stimuli.

6.2.3 P5

6.2.3.1 Verbs

P5 was able to produce only one verb at baseline. She was not able to produce verb affixes or verb sentences at baseline (Figure 6.14).

Figure 6.14 shows the change in the production of verbs, verb affixes and verb sentences associated with the introduction of experimental intervention for P5. The spontaneous production of verbs varied from a level of two in the final baseline session to a level of three in the final treatment session. The change in production of verb affixes was quite variable in the verb affix intervention phase with a maximum of three dropping to a zero in the final treatment probe. The change in production of verbs and verb affixes as a result of the intervention was not found to be statistically significant. Spontaneous production of verb sentences with the structure subject-verb-object (SVO) did not improve at all. Some examples of the kinds of sentences that P5 produced are *the*

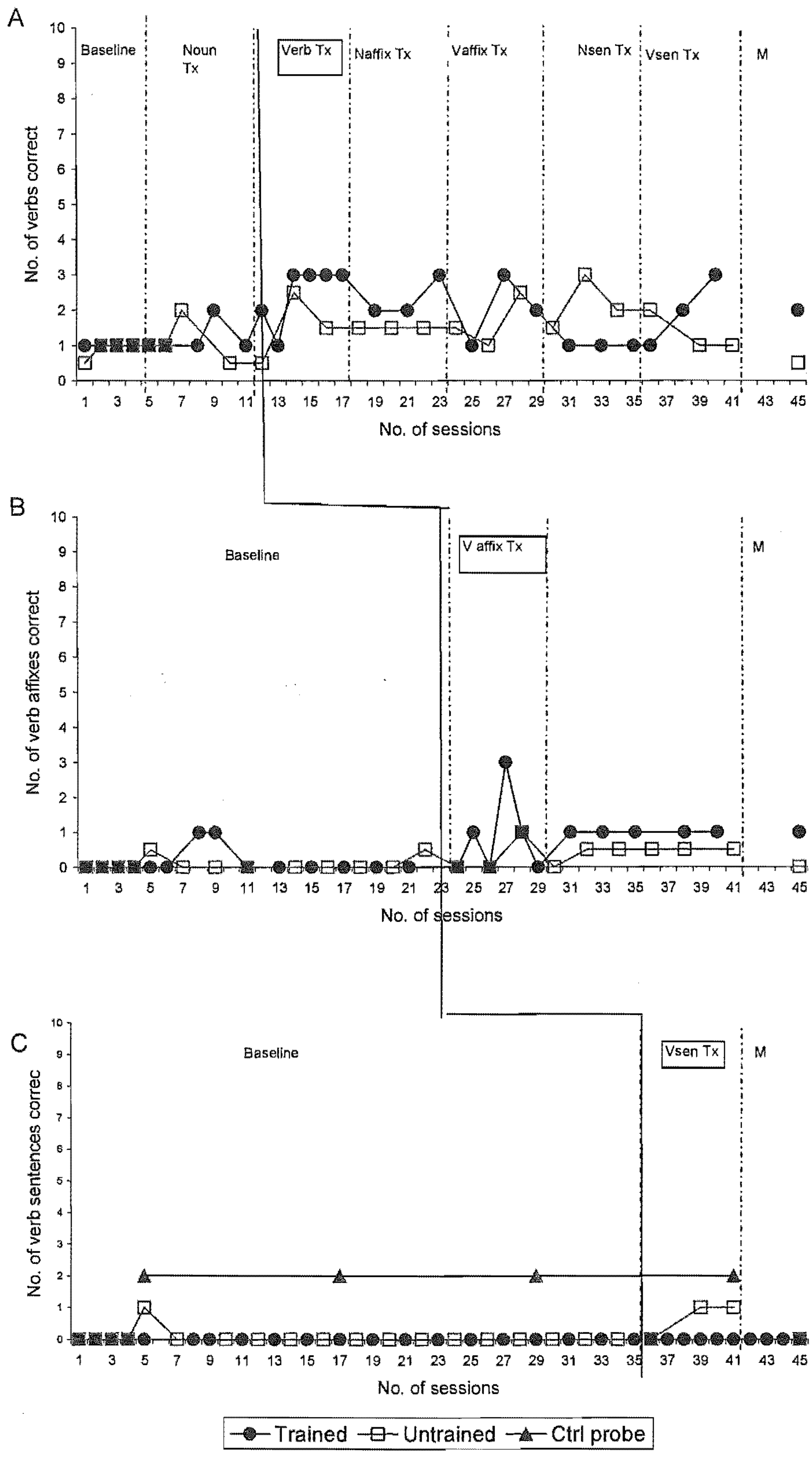

Figure 6.14. **P5:** Session-by-session data record for different verb-forms. The above figure shows the production of verbs in isolation (A, session 12-17), verb affixes (B, session 24-29) and verb sentences (C, session 36-41) associated with the introduction of experimental intervention. Responses for the untrained nouns are scaled out of 10.

boots are very nice (target sentence was *the boy chose the boots*), *she's made a lemon* (target sentence was *the woman squeezed a lemon*), *hello wee boy, he wants his mother to give his yoghurt* (target sentence was *the woman fed some yoghurt to the boy*). No effect of intervention was seen on the untrained verbs, verb affixes and verb sentences.

Maintenance: For the trained verbs and verb affixes, P5 showed poor maintenance (range 1-2 of 10) for the improved verbs and verb affixes (Figure 6.14). P5 did not improve in the production of verb sentences and as a result did not show any maintenance.

Affixes versus lexical stem: For P5, an improvement in the production of verb affixes was seen only in the verb affix intervention phase (session 24-29) for the trained category. For the untrained category, verbs produced were similar to the verb affixes (Figure 6.15).

Changes in sentence structure: P5 could produce well structured sentences at baseline but her sentences were different from the target sentences. For example, at baseline she produced non-target sentences such as *he likes that (the woman fed yoghurt to the boy), I don't know (the woman tore a piece of paper), it's nice of her (the woman spread jam on the bread)*. In an earlier baseline session, she produced sentences such as *he's caught the ball (the woman threw a ball to the boy), giving a present to the girl for something (the man gave the woman a bottle of wine)* and were rescored as correct. After rescoring, the highest number of sentences that she produced at baseline was 3. After the word module, her responses were still incomplete (e.g., *the man* for *the woman asked the man a question, she's given herself a* ...for *the woman spread jam on the bread)*. She produced one target sentence (*the boy has bought some new boots*). After the affix module, her sentences varied from comments (e.g., *his boots are good*) to sentences explaining the picture (e.g., *she has got jam on her piece of bread*). After the sentence module, her sentences were a mixture of target sentences and different sentences (e.g., *she's got two of each* for *the woman tore a piece of paper, she's been away* for *the woman leaned a crutch against the wall*). In this case, her intention seems to be different

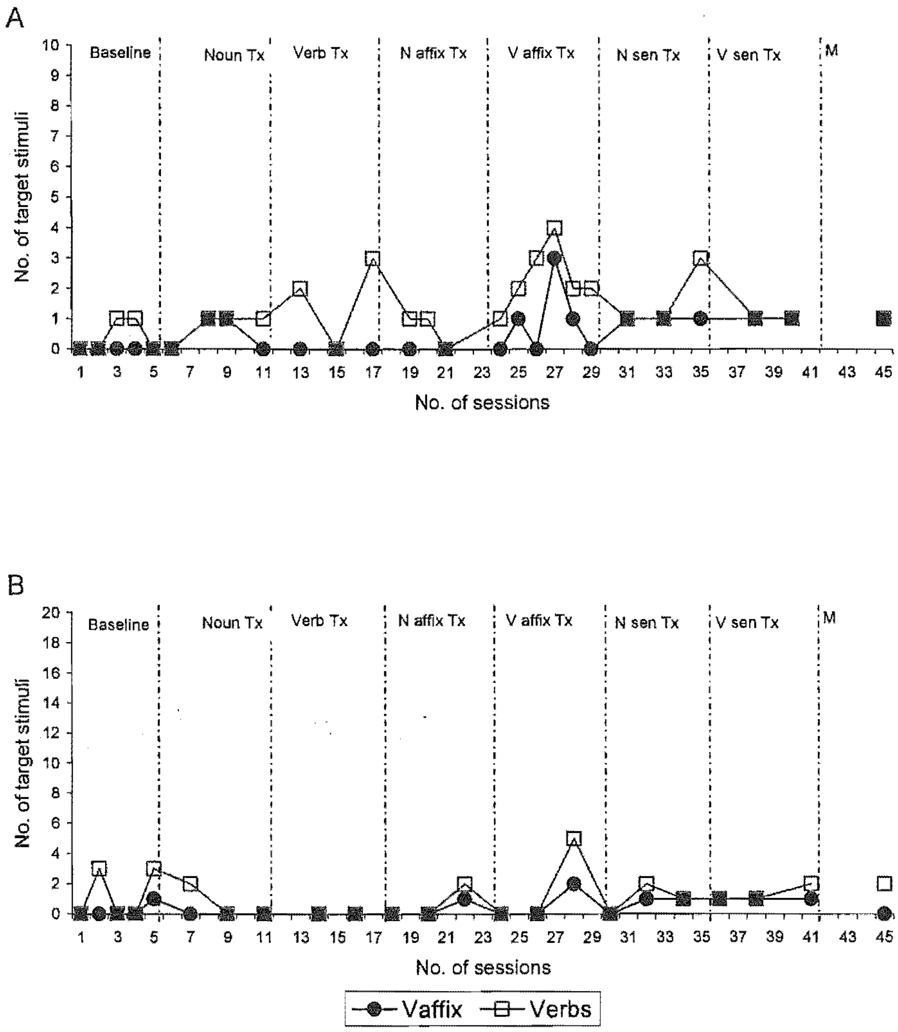

Figure 6.15. Comparison between verb affixes and verbs produced at affix level for P5. Panel A shows the comparison for the trained category and panel B shows the comparison for the untrained category.

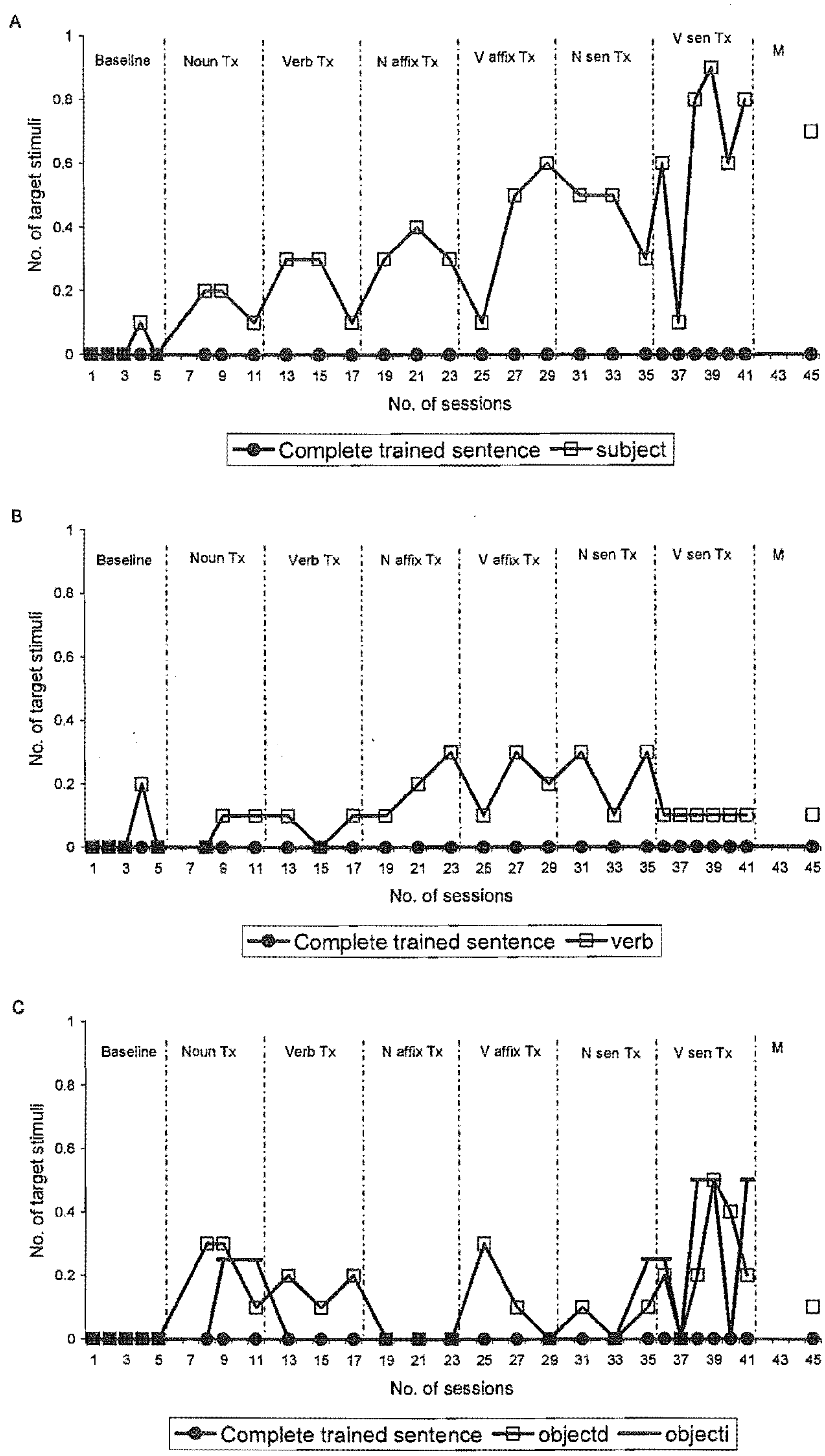

Figure 6.16. Comparison of the number of trained verb sentences and the clause elements produced at the sentence level in P5. Panel A shows the comparison between sentences and the subjects produced, Panel B shows the comparison between sentences and the verbs produced Panel C shows the comparison between sentences and the objects produced. Responses are in proportion correct.

from the target sentences.

Reanalysing the responses: Figure 6.16 depicts the variation in the production of verb sentences and the verbs in the sentence intervention module for trained verb sentences. P5 was not able to produce any verb sentences with SVO structure. There was an increase in the production of subjects (Panel A), verbs (Panel B) and direct objects (Panel C).The production of verbs showed variation across different phases (session 35-41, Panel B). Sentences produced by P5 were rescored[3] to take into account the different types of sentences produced by P5. Sentences such as *he has got some new boots* and *she has been away* were rescored as correct. After scoring, P5's score changed from 3 (baseline), 1 (word), 1 (affix) to 5 sentences after the sentence module.

Generalisation to untrained stimuli: P5 produced incomplete sentences such as *chopping the what is this something* (for *the woman chopped the pepper*), *I don't know why that was clean* (for *the woman washed a shirt for the boy*). After the word module, her sentences were still similar such as *cutting something to make, he's lots of toys* (for *the boy made a castle*). After the affix module, she produced sentences such as *broke the piece into two* (for *the woman broke a stick*). After sentence module, some of the relevant sentences were *he is going to get his boots* (for *the father bought boots for the boy*), *the woman is chopping the* (for *the woman chopped a pepper*). P5'sresponses indicate that she was able to convey the action in the picture but majority of her sentences were incomplete. After rescoring, P5's score changed from zero to 2 sentences after the sentence module but the change was not statistically significant. The rescoring of sentences did not change the scores at baseline or after other modules.

Summary: P5 showed a relatively poor response to the verb modules (in comparison to P1 and P2). She showed a noticeable difficulty in production of sentences with the required sentence structure. Her responses to trained and untrained stimuli show that she was able to produce incomplete sentences and her production of verbs and direct objects was relatively poor in comparison to the number of subjects produced.

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[3] The criteria for rescoring were relevance to the target picture and syntactic and semantic plausibility.

6.2.3.2 Nouns

For nouns, P5 produced a maximum of four nouns at the baseline. At affix level, she produced a maximum of three nouns with the possessive affix. She was not able to produce any sentences with the required grammatical structure (Figure 6.17).

Figure 6.17 shows the change in the production of nouns, noun affixes and noun sentences associated with the introduction of the experimental intervention for P5. The spontaneous production of nouns increased from three in the final baseline session to nine in the final treatment probe session. Noun affixes improved from a level of three at the baseline to a level of ten in the final treatment probe. A decline in the spontaneous production of noun affixes is seen as a result of a discontinuation of the intervention intervention for noun affixes. Panel C shows the change in noun sentences and the graph shows that P5 is not able to produce any sentences of the SVC structure before the intervention. The number of spontaneously produced sentences increases gradually but falls down as soon as the intervention is discontinued. The changes in production of nouns, noun affixes and noun sentences in the word module, affix module and the sentence module respectively were not found to be statistically significant. The untrained nouns changed from 7 (depicted as 3.5) at the baseline to only 9 (depicted as 4.5) as a result of intervention in the word module but noun affixes showed a minimal change during affix module. The change in the production of untrained nouns, noun affixes and noun sentences was not statistically significant.

Maintenance: For the trained nouns and noun affixes, P5 showed maintenance for nouns (6 in contrast to 8 in the final session) in the word module and the noun affixes at a lower level (2 in contrast to 3 in the final session). No maintenance was seen for noun sentences. Untrained nouns were maintained at a level of 7 (depicted as 3.5) in contrast to 9 (depicted as 4.5) in the final session. Untrained noun affixes were maintained at a similar level. No untrained sentences were produced (Figure 6.17).

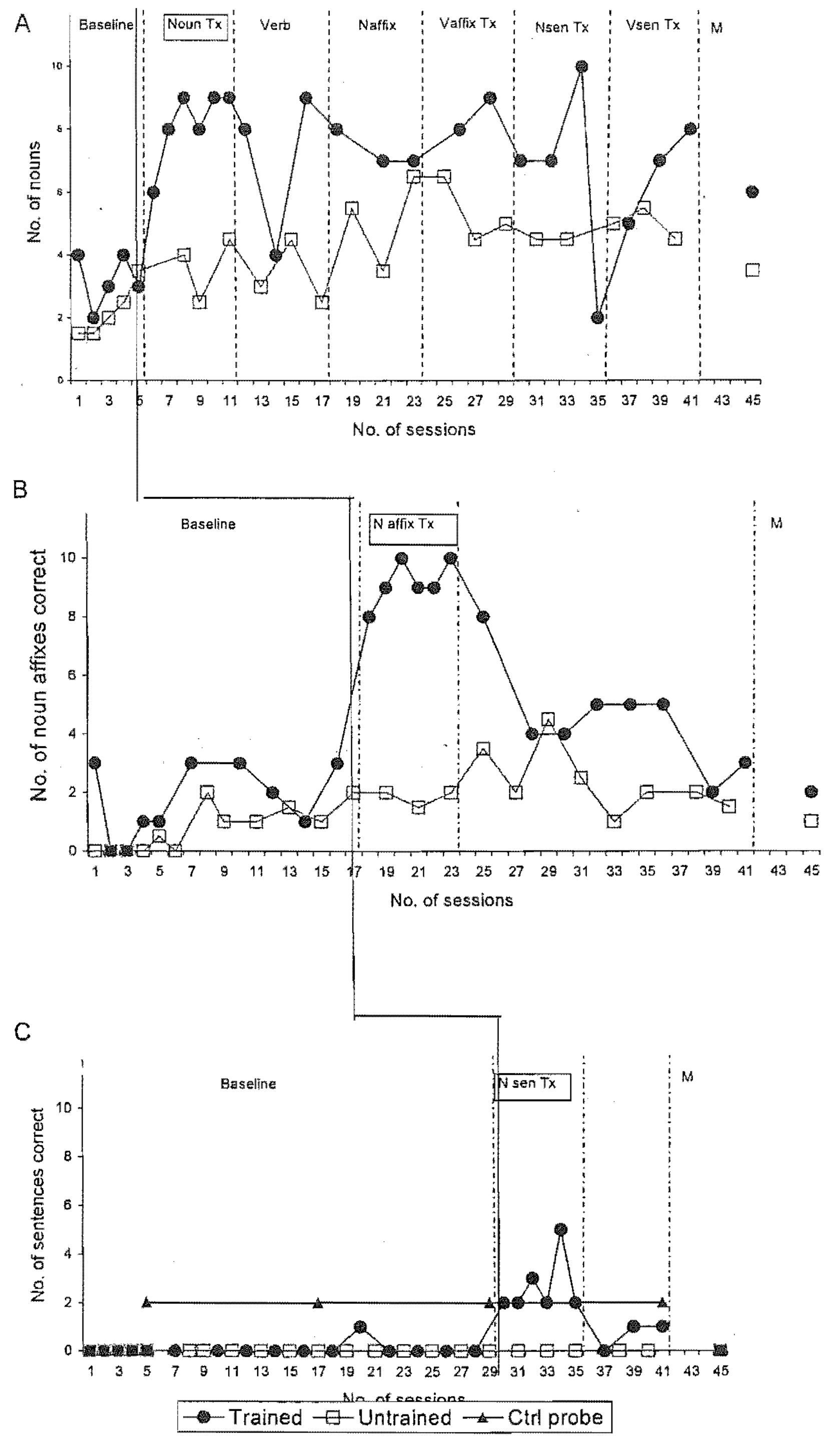

Figure 6.17. P5: Session-by-session data record for different noun-forms. The above figure shows the production of nouns in isolation (A, session 6-11), noun affixes (B, session 18-23) and noun sentences (C, session 30-35) associated with the introduction of experimental intervention. Responses for untrained nouns are scaled out of 10.

Affixes versus lexical stem: A comparison between the noun affixes produced and the total number of nouns produced was made both for the trained category and the untrained category for P5. In the trained category (panel A), P5 was not able to produce the noun affixes until the affix module of intervention (sessions 18-23) for noun affixes. A large difference was seen in the production of the noun affixes and the nouns. The total number of nouns produced was high but there was a relatively poor production of the noun affixes in comparison to the nouns throughout the entire intervention. In the untrained category, the difference between the production of noun affixes and nouns varied with a maximum difference of eight in session 33 (Figure 6.18). For the untrained category, more nouns were produced in comparison to the noun affixes.

Changes in sentence structure: P5 produced utterances such as *the cook good (the chef's meal is tempting), the man (the cobbler's shop is messy), making a plant of a cane (the florist's bouquet is beautiful)* at the baseline. After the word module, she produced different sentences such as *the cook has a good meal, the donkey is on his home, the man is busy*. After the affix module, she still produced sentences different to the target sentences (e.g., *you have got good people* for *the teacher's class is active*). After the sentence module, she produced some target sentences and some sentences without the noun phrase (e.g., *the donkey is very big, the chef is very good*). Though the sentence structure produced by P5 was similar (SVC) to the target structure, the sentences produced included sentences such as *the chef is good in his job (the chef's meal is tempting), the cow is a good cow (the cow's face is black).* Some of the sentences produced were incomplete such as *the man has a very bad (the man's arm is hurt), the florist is in a good (the florist's bouquet is beautiful).* This variation from the target sentences resulted in no score for such sentences. The sentences with a similar syntactic structure (SVC without the target noun phrase, e.g., *the donkey is very big* for *the donkey's face is big, the cow is black for the cow's face is black*) were rescored as

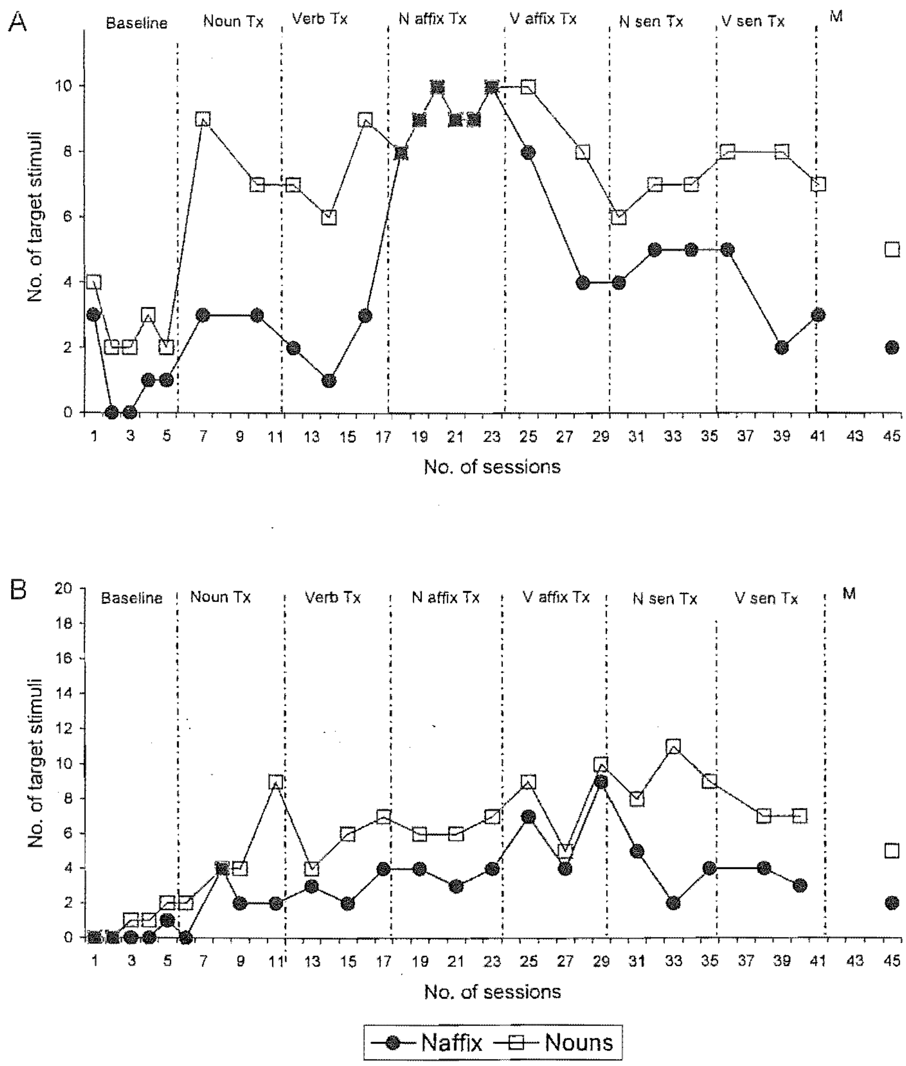

Figure 6.18. Comparison between noun affixes and nouns produced at affix level for P5. Panel A shows the comparison for the trained category and panel B shows the comparison for the untrained category.

correct. Rescoring of sentences indicates that P5 was able to produce zero sentences at baseline, 3 sentences after the word module, four sentences after the affix module and six sentences after the sentence module. The change from four sentences to six sentences was not statistically significant.

Reanalysing the responses: Figure 6.19 depicts the variation in the production of trained noun sentences and the clause elements produced during the sentence intervention module in P5. Panel A shows that there is a maximum increase in the production of noun sentences in the sentence intervention phase (from session 30-35) but a similar increase in the number of subject elements is not seen. There is an overall small change in the production of subject clause elements. In Panel B, we can see that the number of verbs (copula) produced is higher than the noun sentences produced throughout the entire intervention. The number of complements produced during noun sentence intervention phase (session 30-35) (Panel C) correlate with the change in the number of noun sentences produced.

The increase in the number of subjects and verbs indicates an increase in the number of sentences produced. However, the scores of P5 show a low number of sentences produced. The low number of sentences produced is mainly due to the difference in the noun phrase produced.

Figure 6.20 shows a comparison of the different clause elements produced during the production of untrained noun sentences. P5 did not produce any untrained noun sentences. She produced a high number of subject clause elements (Panel A) and a lower number of complements (Panel C). The production of the copula was variable during production of untrained noun sentences (Panel B).

Generalisation to untrained stimuli: P5 showed a change in the production of nouns and noun affixes that was not statistically significant (Figure 6.17). For untrained sentences, P5 produced utterances with a few words that were related to the target sentence. For example, at the baseline, she produced utterances such as *the monkey is big*, *the artist makes many people*. Some of her utterances were incomplete such as *the man is* (for *the artist's painting is beautiful*), *the man is..a very good fish* (for *the fisherman's*

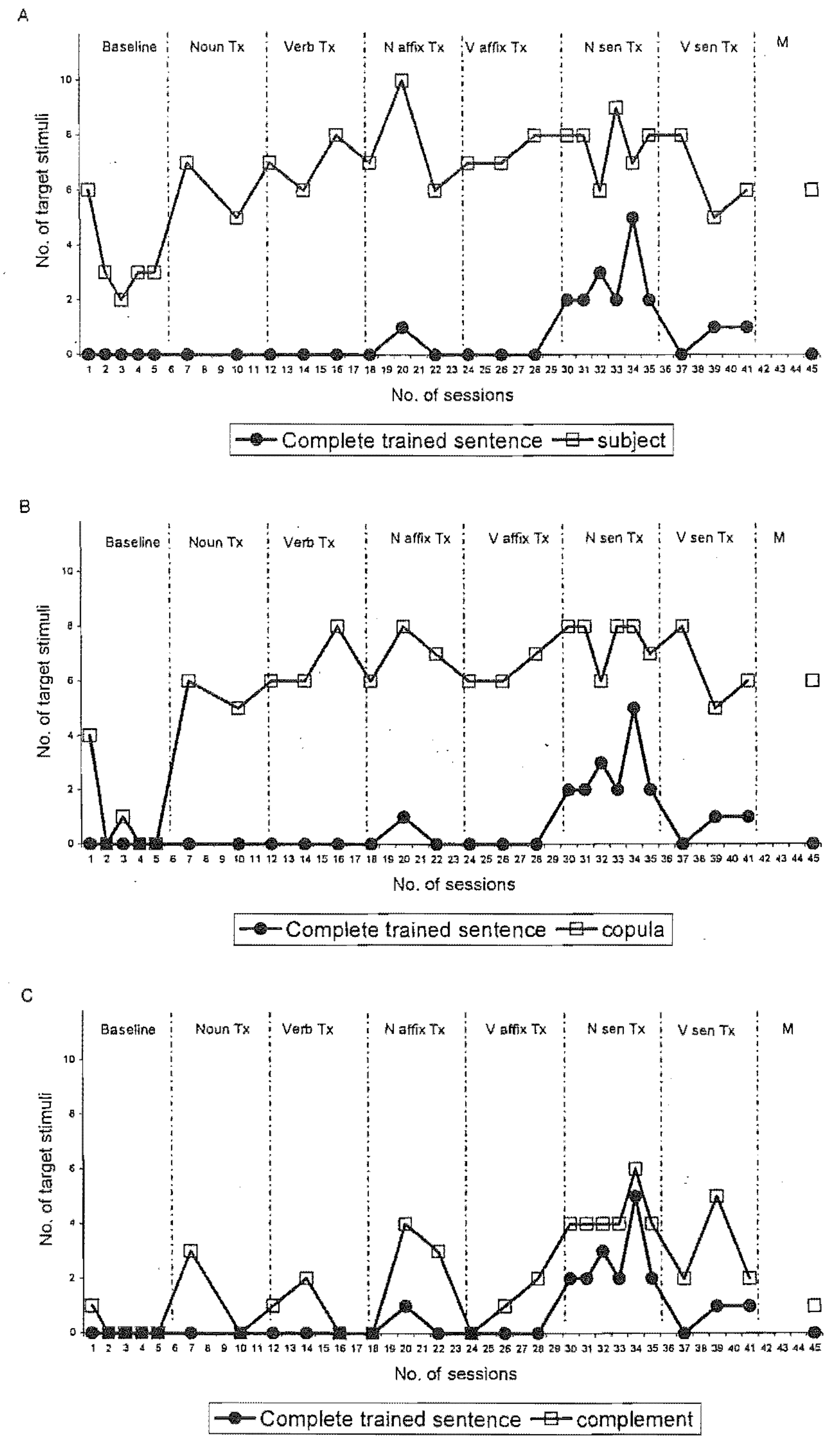

Figure 6.19. Comparison of the number of trained noun sentences and the clause elements produced at the sentence level in P5. Panel A shows the comparison between complete trained sentences and the nouns produced, Panel B shows the comparison between complete sentences and copulas produced, and Panel C shows the comparison between complete sentences and complements produced.

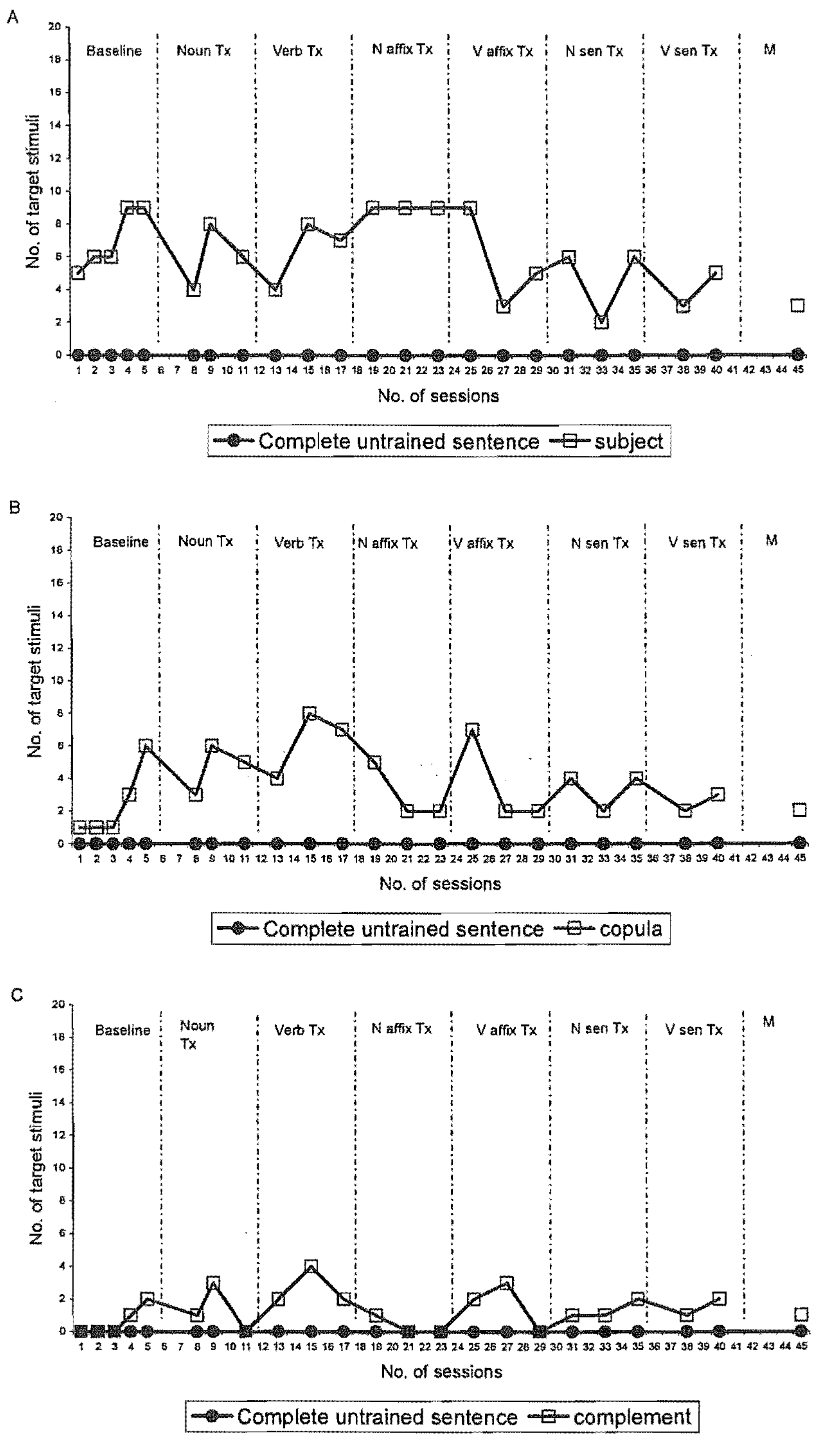

Figure 6.20. Comparison of the number of untrained noun sentences and the clause elements produced at the sentence level in P5. Panel A shows the comparison between complete untrained sentences and the nouns produced, Panel B shows the comparison between complete sentences and copulas produced, and Panel C shows the comparison between complete sentences and complements produced.

catch is big). Other examples are I *can't say what he is doing*. After the word module, she produced sentences such as *the man is painting a picture*, *the gardener is taking the weeds from the*. After the affix module, she produced sentences such as *monkey is dirty boy*, *the patient is very better today*. After the sentence module, the sentences were still similar (e.g., *the monkey is naughty*, *the fisher has got a*).

Summary: P5 did not show a statistically significant change in the production of nouns, noun affixes and noun sentences. During the sentence module, she was able to produce some elements of the target sentences but her sentence structure was different. An increase in the production of subjects and copulas was seen during all the intervention modules. However, an increase in the number of complements was prevalent in the sentence module.

6.2.4 Other aspects of generalisation

From one level to another level of intervention:

One of the important questions of the study was to find out if the verbs/nouns trained in isolation would generalise to production of verb affixes and noun affixes; and if the training at the word module and/or at the affix module would generalise to the production of verb sentences and noun sentences. This relationship was evaluated in all the participants and the findings were two. First, no generalisation occurred from training of verb stems to verb stem + affixes or from either verb stem or verb affix intervention to verb sentences. Second, no generalisation occurred from training of noun stems to nouns stems + affixes or from either noun stem or noun affix intervention to noun sentences. The interesting part was that the sentence graphs for P1 showed some activity at the affix level of intervention. When the verb affixes were trained, there was some activity in the verb sentences, and similarly some change from noun affixes to noun sentences was seen but none of these changes were found to be statistically significant. For verbs, the lack of generalisation from the verb in isolation to the production of the verb at sentence level was contrary to what was expected according to the model. For nouns, no generalisation from training at word level (in isolation) to the affix level or the sentence level was seen as predicted.

From one grammatical class to another:

When verbs or any of the verb forms were trained, no improvement in the production of nouns or noun forms was seen for any of the participants except P1. P1 showed a visual increase in the production of noun affixes during the treatment of verb affixes. This increase in the production of noun affixes is likely to be a result of the noun module immediately before the improvement. Training of nouns and noun forms did not have an improvement effect on the production of verbs or verb forms as expected.

6.3 Spontaneous speech

The speech samples obtained for every participant were analysed using the Language Assessment, Remediation and Screening Procedure (LARSP) (see chapter 5, section 5.8.7). This section will describe only those variables that were evaluated for reliability and found to be statistically reliable (see chapter 5, section 5.8.7). Four of the five tested variables that showed reliability included total utterances, clausal complexity, number of verbs and number of nouns. Clausal complexity tells us about the complexity of the clauses produced at different LARSP stages. Clausal complexity indirectly relates to the verb arguments produced. The types of verbs produced tell us about the types of sentences because a verb is classified based on the clause elements produced with that particular verb. The description of the variables will be followed by an evaluation of the results to find the module of intervention responsible for a maximum increase in a particular variable. The scores obtained in the four samples for all participants are presented in Tables F.1 - F.6 (see Appendix F) along with the mean and range values of spontaneous speech measures for normal speakers. Table 6.1 shows the response of the participants who improve (P1, P2 and P5) in terms of the reliable variables. The transcripts of these participants are presented in Appendix F.

LARSP measures obtained at the baseline and during the intervention (i.e., post-word, post-affix and post-sentence) were compared to evaluate the changes in spontaneous speech after each module in relation to the baseline. In addition, LARSP measures for the three intervention modules (i.e., post-word, post-affix and post-sentence) were compared to find the module resulting in a maximum increase in the spontaneous speech measures. Inter-subject and intra-subject reliability measures for normal speakers were performed (see chapter 5, section 5.8.7). A similar comparison for the participants would have required at least ten speakers and therefore could not be performed. Because of the low level of intra-speaker variability in the normal speakers, we tentatively assume that there may be a similar relatively low level of intra-speaker variability for the experimental participants and interpret significant changes in spontaneous speech as the result of the intervention rather than random intra-speaker variability.

P1: For P1, data are presented excluding picture 5 because P1 did not respond to picture 5 in one of the samples (sample 3). The variables that changed after the intervention modules in comparison to the baseline values were the total utterances produced, clausal complexity, and the number of nouns and verbs produced (see Table 6.1). Variability in performance was seen for P1 after each module. The verb tokens showed an increase after each module in relation to the number produced at baseline. Regarding the type of verbs produced, the intransitive verbs showed a consistent increase unlike transitive verbs that showed a transient change after the word module. Overall more intransitive verbs were produced than transitive verbs supporting the finding that people with aphasia use verbs with simple argument structures (e.g., Thompson et al., 1997a). Improvement in the spontaneous speech as a result of the intervention is evident in that P1 used some of the trained nouns in the speech samples. For example, she produced *man, woman, fire engine, ladder* and also used the possessive affix (e.g., *man's arm, man's ladder, woman's arm*).

P2: Table 6.1 shows that for P2, the variable that changed after the intervention modules in comparison to the baseline values was the number of nouns produced. The effect of intervention on spontaneous speech is again evident in the use of trained nouns in the speech samples. For example, P2 produced some of the nouns in the trained list (e.g., *fire engine, ladder*) and produced the subject more often than in the baseline sample (e.g., *Dad, mum, lady*).

In comparison to normal speakers, the number of utterances produced by P2 is high because she has a high number of problematic utterances. For P2, problematic utterances consist mainly of stereotypes (e.g., *here beside me*).

P5: Table 6.1 shows that there is an increase in the total utterances after the affix module and a fluctuating increase in the nouns and verbs produced for P5. There was an

Table 6.1 Mean and range values of spontaneous speech measures for normal speakers and from four samples of P1, P2 and P5 obtained during baseline, after module1 (post-word), module 2 (post-affix) and module 3 (post-sentence).

Measures	Mean	Range	Baseline	Post-word	Post-affix	Post-sentence
P1						
Total utterances	31.78	19-54	25	38	26	39
Clausal complexity	9.91	7.33-15.83	1.41	2.14	1.64	2.17
Lexical						
Nouns – Types	47.07	31-75	17	25	11	17
Nouns – Tokens	66.85	38-126	20	37	17	35
Verbs – Types	35.85	23-62	3	15	6	19
Verbs – Tokens	51.21	28-90	3	17	12	24
Verb valency						
Intransitive types	17.28	6-36	0	3	3	15
Intransitive tokens	23.92	8-48	0	3	9	20
Transitive verbs – Types	19.00	12-28	3	11	3	4
Transitive verbs – Tokens	26.28	15-52	3	14	3	4
P2						
Total utterances	31.78	19-54	72	84	78	77
Clausal complexity	9.91	7.33-15.83	1.15	0.94	1.03	1.11
Lexical						
Nouns – Types	47.07	31-75	9	15	21	17
Nouns – Tokens	66.85	38-126	15	37	39	33
Verbs – Types	35.85	23-62	1	1	1	2
Verbs – Tokens	51.21	28-90	2	1	2	3
Verb valency						
Intransitive types	17.28	6-36	1	0	1	1
Intransitive tokens	23.92	8-48	2	0	2	1
Transitive verbs – Types	19.00	12-28	0	1	0	1
Transitive verbs – Tokens	26.28	15-52	0	1	0	2
P5						
Total utterances	31.78	19-54	42	42	87	49
Clausal complexity	9.91	7.33-15.83	10.21	9.58	5.29	6.49
Lexical						
Nouns – Types	47.07	31-75	18	21	30	21
Nouns – Tokens	66.85	38-126	23	32	46	30
Verbs – Types	35.85	23-62	9	22	28	25
Verbs – Tokens	51.21	28-90	23	37	76	43
Verb valency						
Intransitive types	17.28	6-36	4	9	12	6
Intransitive tokens	23.92	8-48	9	14	18	12
Transitive types	19.00	12-28	5	13	14	17
Transitive tokens	26.28	15-52	14	23	49	17

increase in the production of intransitive, transitive and ditransitive verbs. P5 was the only participant to produce ditransitive verbs. After the affix module, there was a maximum increase in the total number of utterances, nouns, and verbs. After the sentence module, specifically transitive verbs improved to a maximum.

Modules and changes in spontaneous speech: P1 improved in the production of nouns and verbs after the word module. This can be explained by the focus on nouns and verbs in the word module. The increase in the verbs produced after the sentence module can be explained by the verb argument information explicit in the sentence module. P5 showed an improvement in the number of total utterances produced after the affix module. Thus, the variation in the responses of the participants made it difficult to pinpoint a particular module that would be more beneficial than others in terms of an improvement in spontaneous speech. The word module and the sentence module both in combination may prove to be more beneficial than just one of them.

Summary – spontaneous speech: Spontaneous speech improved in three participants in terms of a change in the number of utterances produced and the number of verbs and nouns produced. The extent of improvement in terms of the different aspects of spontaneous speech varied in the participants.

6.4 Post-intervention battery

The pre-intervention test battery was re-administered after the intervention to see if the improvement seen as a result of the intervention could be detected by any of the standardised tests. McNemar's test was used to test the statistical significance of the change in scores. Table 6.2 presents the scores of the pre- and post-intervention battery for P1, P2 and P5.**P1**: In the Verb Production Battery, scores improved for verb production in isolation and for production of direct objects and verbs in sentence production. The change in scores for verb production in isolation ($p = 0.035$, 1-tailed) and for direct objects produced during sentence production ($p = 0.006$, 1-tailed) was found to be statistically significant using McNemar's test. In PALPA, the score for subtest 47 had already reached ceiling and thus no change could be seen.

P2: None of the changes in BDAE were statistically significant. In the verb production battery, a remarkable change in the number of subjects was seen post intervention and was statistically significant ($p < 0.005$. 1-tailed). A drop in the number

Table. 6.2. Comparison of pre and post intervention battery results for P1, P2 and P5. Auditory C (auditory Comprehension), V prod (verb production), V comp (verb comprehension), Subtest 47 (spoken word-picture matching), subtest 53 (spoken picture naming), SR (subject relative). OR (object relative). An asterisk indicates statistical significance using McNemar's test at $p<0.05$ level.

Measure	P1 (pre)	P1 (post)	P2 (pre)	P2 (post)	P5 (pre)	P5 (post)
BDAE (raw scores)						
Fluency (21)	8	15	6	9	17	17
Conversation (7)	7	7	6	6	7	7
Naming (37)	34	37	13	9	16	20
Auditory C (32)	32	31	24	24	25	26
Repetition (7)	5	5	4	5	4	4
Reading (39)	35	28	26	23	24	33
Articulation (7)	3	4	3	3	5	5
Verb Production Battery						
V prod (25)	16	23*	2	2	10	13
V comp (25)	23	24	23	24	22	25
Sentence Production						
Subject (31)	17	16	6	23*	24	18
Direct object (21)	8	17*	1	4	6	5
Indirect object (7)	1	1	0	2	0	1
Verb (31)	25	29	14	8	12	7
PALPA						
Subtest 47 (40)	40	40	37	32	38	39
Subtest 53 (40)	36	39	9	12	15	30*
Sentence comprehension test						
Active (20)	11	13	9	11	11	16
Passive (20)	10	11	11	10	13	7
SR (20)	14	11	9	11	10	14
OR (20)	11	12	5	7	8	6

of verbs produced during sentence production was not found to be statistically significant. The changes in PALPA subtests were not statistically significant.

P5: None of the changes in BDAE and the Verb Production Battery were found to be statistically significant. The increase in the production of nouns in the PALPA subtest 53 was statistically significant ($p = 0.01$, 1-tailed).

6.5 Final summary

Six individuals with aphasia participated in Study 1. These participants varied in their speech output and in their language impairment profile as assessed by a standardised language assessment. These six participants responded to the experimental intervention in different ways. **Intervention**: P1 and P2 showed a good response to the intervention in terms of an increase in the trained items in each module. P1 showed the most positive response to the experimental intervention among the six participants. The improvement seen in P1 was found to be statistically significant. Additionally, P1 showed a statistically significant change in the production of verbs in isolation and direct objects produced during sentence production in the post intervention battery. P2 showed a statistically significant change in the production of nouns, noun affixes and noun sentences. P2 showed a statistically significant change in the production of subjects during sentence production. P5 showed a differential response to nouns and verbs with a good response to the noun modules only. P3, P4 and P6 did not show significant changes in the production of trained items. None of the participants showed significant changes in the production of untrained stimuli.

A comparison of the verbs produced in the word module to the number of sentences produced in the sentence module showed that there was no consistent relationship between verb retrieval and sentence production. The number of verbs produced in isolation was not directly proportional to the number of sentences produced.

Generalisation to untrained items:

Spontaneous speech: P1 and P2 improved in the total number of nouns and verbs produced during spontaneous speech production in response to different pictures.

Table 6.3 Summary of results for participants P1, P2 and P5 for the intervention and generalisation to untrained items and spontaneous speech. Only significant changes to the pre- and post-intervention battery are listed. NS (= non – significant), VPB (= verb production battery)

	P1	P2	P5
Intervention	Trained	Trained	Trained
Verbs - Word	Significant	Increase	Minimal change
Verbs - Affix	Significant	Increase	Minimal change
Verbs - Sentence	Significant	Increase	No change
Nouns - Word	Increase	Significant	Increase
Nouns - Affix	Increase	Significant	Increase
Nouns - Sentence	Increase	Significant	Increase
Spontaneous speech	Increase in verbs tokens. Consistent change in intransitive verbs	Increase in the number of nouns produced	Total utterances (post-affix). Fluctuating increase in nouns and verbs
Pre-and post-intervention battery	Verbs in isolation Direct objects (VPB)	Subjects (VPB)	Noun production (PALPA)

Pre-and post-intervention battery: Statistically significant changes were seen in some of the sub-tests of PALPA and the Verb Production Battery. P1showed significant changes in the production of verbs, while P2 and P5 showed significant changes in the production of nouns.

Discussion: P1 showed a significant change in the production of the trained items in the three verb modules and this change is supported by changes in the production of verb (mainly intransitive verbs) in spontaneous speech and significant changes in the Verb Production Battery. Similarly, P2 showed significant changes in the production of the number of nouns in spontaneous speech and a significant change in the production of subjects. P5 did not show a significant change in the production of verbs or nouns during the intervention though she shows a significant change in the production of nouns (PALPA). None of these participants showed generalization from training verbs in isolation to production of sentences in contrast to the predictions of GEM.

Thus the six participants showed a range of performance patterns varying in the magnitude of improvement seen in the different language measures (see Table 6.3). In two of the six participants (P1 and P2), the improvement seen in the production of trained items was related to an improvement in the overall speech in everyday life but the others showed a varied response in terms of the magnitude of improvement in the different modules and also in spontaneous speech. The variation seen in the results is discussed in Chapter 7.

7 Chapter Seven: Discussion – Study 1

7.1 Introduction

The purpose of the current study was to use a cognitive neuropsychological approach for intervention for sentence production disorders in patients with aphasia to test the validity of the model of sentence production used in the study.

The main questions asked in Study 1 were:

1. Does an intervention based on the grammatical encoding model (i.e., GEM), result in an increase in the production of target sentences in patients with aphasia? This overarching question included four specific questions:
   a) Does each intervention module result in an increase in the trained items in that particular module?
   b) Does intervention in the word module focusing on verbs result in an improvement in the production of target sentences?
   c) Does intervention in the word module focusing on nouns result in an improvement in the production of the target sentences?
   d) Does intervention in the affix modules for verbs and nouns, respectively, result in an improvement in the production of the target sentences?
2. Does the effect of the experimental intervention on one grammatical class generalise to another class i.e., from verbs to nouns and vice versa?
3. Does the effect of the experimental intervention on trained stimuli generalise to untrained stimuli?
4. Does the effect of the experimental intervention generalise to an increase in production of utterances in spontaneous speech?

7.2 Results and discussion

The results obtained will be discussed in terms of the hypotheses of Study 1. The terms *noun sentences*[1] and *verb sentences* refer to the sentences used in the sentence module in Study 1.

7.2.1 Explanation of results in terms of the hypotheses

7.2.1.1 Hypothesis 1 (i)

Each intervention module will result in an increase in the accurate production of trained items in that particular module.

The improvement in the trained items for the three verb modules was statistically significant ($p<0.05$) for P1. The improvement for the three noun modules was not statistically significant. P2 showed a statistically significant ($p<.05$) increase in the trained items for the three noun modules. Results of P1 and P2 lent support to this hypothesis but the results of P3, P4, P5 and P6 failed to support this hypothesis because the increased production of trained items in these participants was not statistically significant. In summary, hypothesis 1(a) was supported by the results of P1 (verb modules only) and P2 (noun modules only).

7.2.1.2 Hypothesis 1 (ii)

An association between verb retrieval and sentence production will be established by the results of the experimental intervention, i.e., improvement in verb retrieval will generalise to an increase in the production of target sentences because the lemma of the verb once retrieved will activate the argument structure and the planning frame for the sentence according to GEM. An increase in the production of verbs in the word module did not generalise to an increase in the production of target sentences in any of the participants. These findings were inconsistent with hypothesis 1 (b) of the study. Therefore, this hypothesis was not supported.

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[1] Noun sentences and verb sentences here, as elsewhere in this study, refer to the sentences used for training in the sentence module. Noun sentences refer to sentences with the grammatical structure subject-verb-complement (SVC) (e.g., *the man's arm is hurt*) and verb sentences refer to the sentences with the grammatical structure subject-verb-object (SVO) (e.g., *the woman wiped the board*) and subject-verb-object-object (SVOO) (e.g., *the woman asked the man a question*)

7.2.1.3 Hypothesis 1 (iii)

An association between noun retrieval and sentence production will not be established by the results of the experimental intervention, i.e., improvement in noun retrieval will not generalise to an increase in the production of target sentences because the noun lemma does not activate the argument structure. P2 was the only participant who showed a statistically significant increase in the production of nouns. An increase in the production of nouns in the word module did not generalise to an increase in the production of target sentences in the sentence module for any of the participants. These findings were consistent with hypothesis 1 (c).

7.2.1.4 Hypothesis 1 (iv)

Improvement in affix production for verbs and nouns will generalise to an increase in the production of target sentences because the retrieval of affixes should indirectly retrieve the planning frame of the sentence. For participants P1-P6, the finding of no increase in the production of sentences during treatment for verb and noun affixes, respectively, is inconsistent with hypothesis 1 (d). Therefore, hypothesis 1 (d) was not supported. P1 showed a trend towards an increase in the production of sentences.

7.2.1.5 Hypothesis 2

Improvement in one grammatical class will not result in generalisation to any other grammatical class in any of the modules, i.e., in word-, affix- or sentence module because nouns and verbs belong to different grammatical classes and information about grammatical class is retrieved along with the lemma at the functional level. The experimental intervention did not result in generalisation from one grammatical class to another in any of the modules for P1 and P2 (the participants who showed a significant improvement). This result was consistent with hypothesis 2.

7.2.1.6 Hypothesis 3

Improvement of trained stimuli will result in generalisation to untrained stimuli in each module within each grammatical class, i.e., in the word module there will be a generalisation from trained words to untrained words; in the affix module there will be a generalisation from trained word affixes to untrained word affixes; and, in the sentence module, there will be a generalisation from trained sentences to untrained sentences. The improvement in the production of the trained stimuli seen in response to the experimental intervention for P1 and P2 did not generalise from trained to untrained stimuli for verbs and nouns. No generalisation from the trained stimuli to the untrained stimuli was seen as expected in the other four participants because these participants did not improve in their production of the trained stimuli. The results were not consistent with hypothesis 3.

7.2.1.7 Hypothesis 4

Improvement resulting from the experimental intervention will result in generalisation to spontaneous speech (i.e., as measured by an increase in the total number of utterances) as a cumulative effect of all the three modules. The two participants (P1 and P2) did not show generalisation from intervention from experimental intervention to spontaneous speech. Therefore, hypothesis 4 is not supported.

7.3 Questions raised by the results

The results of Study 1 raise the following questions:

1) Why was there a variation in the performance of the participants in terms of the effect of intervention on trained items?
2) Why did an increase in the production of verbs not generalise to an increase in the production of target sentences?
3) Why did all the participants not show generalisation from the affix module to production of target sentences?
4) Why did the effect of experimental intervention not generalise from trained to untrained stimuli?
5) Was the change in scores seen in P1 and P2 a generalisation from the experimental intervention to spontaneous speech?
6) What is the significance of the results for the theoretical validity of GEM?

These questions will be addressed in the same order as listed.

7.4 Variation in performance

One possibility is that the variability of performance among participants in the present study can be explained by a difference in the hypothetical locus of impairment –

as specified by GEM, performance on the Verb Production Battery and PALPA, and by language profiles as identified by the BDAE.

7.4.1 Hypothetical locus of impairment

An analysis of an individual's pre-intervention baseline performance provides the basis for identifying the locus of impairment in terms of GEM. The purpose of considering the locus of impairment is to verify if the hypothetical locus of impairment would relate to the performance pattern of each participant and to explain possible reasons for the heterogeneity of the results. The analysis of level of impairment for all participants is described in the following sections.

Participant 1:

Analysis of P1's pre-intervention battery revealed three main symptoms:

a) poor verb retrieval in comparison to noun retrieval;
b) limited use of verb-related grammatical morphemes i.e., auxiliary verbs and inflections; and
c) inability to produce all the clause elements of a sentence.

At the baseline testing for verbs in isolation, P1 produced utterances such as *got* (for *feed), man* (for *ask), bottle of wine* (for *give), finished* (for *shred).* Substitution of general verbs such as *got, finished* for specific verbs such as *feed, shred* indicates that she has access to meaning but is not able to retrieve the appropriate lexeme for what she wants to say. These deficits can be linked to several probable points of failure in the sentence production process. A possibility of a failure at the functional level in terms of the verb lemmas is remote, because her comprehension of verbs and nouns is very good. Impairment at the functional level in assigning functional and grammatical roles is not evident in production tasks, because no mismatch of roles was evident in her limited spontaneous speech or in her responses during the sentence production subtest of the Verb Production Battery. However, a difficulty in assigning functional and grammatical roles was evident in the sentence comprehension task.

The sentence comprehension test was administered to assess the comprehension of four different types of sentences and her performance was found to be at chance level for active and passive sentences. The focus of the current study was on training of active sentences only. Even if P1 had impairment at the functional level in terms of assignment of functional and grammatical roles, it should not affect the production of active sentences. A possibility of a failure at the positional level exists in terms of retrieval of the lexeme and also in the retrieval of all the features of the planning frame i.e., articles, determiners etc. A problem in retrieval of lexemes is also supported by phonemic errors (see chapter 5, Table 5.17) in response to nouns in isolation (PALPA subtest).

In summary, P1's good comprehension and poor production strongly indicate a problem at the positional level, possibly, at the stage of lexeme retrieval, a conclusion that is supported by her improved sentence production with a written verb clue (in the sentence production subtest of the Verb Production Battery). P1's locus of impairment at the positional level relates to her performance pattern because providing the target lexeme resulted in an improvement in the target behaviors.

Participant 2:

An analysis of the pre-intervention battery performance by P2 revealed three main symptoms:

a) poor verb retrieval and poor noun retrieval;
b) limited use of grammatical morphemes i.e., auxiliary verbs and inflections; and
c) inability to form a simple subject-verb-object sentence.

These symptoms point to several probable points of failure in the sentence production process. Failure may occur at the functional level in terms of the lack of specification of thematic roles and grammatical roles or at the positional level in terms of the retrieval of lexemes and the specification of the planning frame.

P2 responded with one word utterances such as *no, jump, ball* for some of the items at the baseline. Her responses consisted of nouns mainly and there was no evidence of a planning frame in her utterances.

The language test data provide a picture of a person with good comprehension (92% approximately) of verbs and nouns but poor production of both the lexical categories. Her responses to nouns in isolation (PALPA subtest) include semantic and phonemic paraphasias. Her good comprehension and presence of semantic paraphasias implies that she is unable to retrieve the lexeme of the lexical item that she wants to produce. This was evident in her speech behavior as she tried to access the phonological output through finger spelling the word first. An additional problem of specification of the planning frame may coexist and explain her inability to produce a sentence. P2's performance pattern indicates that she has an additional problem besides lexeme retrieval because she is not able to produce all the target behaviors on presentation of the lexemes. The magnitude of improvement for P2 is at a lower level than for P1.

Participant 3:

An analysis of the pre-intervention battery performance by P3 indicates:

a) Poor production and comprehension of both nouns and verbs;
b) Utterances limited to one word fragments without any evidence of sentence structure; and
c) Good repetition

These features strongly imply impairment at the lemma or semantic level. Responses to production of nouns in isolation indicate a large component of distant semantic distractors and unrelated distractors (see chapter 5, Table 5.17). A failure at the positional level may coexist with the impairment at the functional level. Good repetition indicates that P3 is able to access the phonological form but not necessarily activate the lemma of that phonological form. P3's hypothetical locus of impairment at the functional and the positional level is supported by his poor performance pattern.

Participant 4:

An analysis of P4's pre-intervention battery performance indicates:

a) Poor speech production because speech consisted largely of unintelligible utterances;
b) Awareness of the errors she makes; and
c) Production of utterances with appropriate sentential intonation but most of the speech was unintelligible.

The language data point to a failure at the positional level in terms of retrieval of lexemes. In addition, it points to a weak link between the lemma and lexeme as the participant typically produced an unintelligible utterance or an irrelevant word in place of the target lexemes. Her responses to nouns in isolation consisted of unrelated paraphasias.

An important feature of P4's speech production was that she would produce many utterances but most of them were unintelligible (non-words). She would try to produce a particular word and as soon as she would produce an unintelligible word, she would stop herself and try to self-correct. Her awareness of the errors she made indicated that she knew what she wanted to say but could not retrieve the intended word. Her production of unintelligible words indicated that the lemma retrieved did not match the lexeme produced suggesting a loss of connection between the lemma and lexeme. This hypothetical locus of impairment is supported by her poor improvement after the intervention. The therapy task helped this participant to strengthen the link between the lemma and lexeme as evident by her ability to produce the target words during production in the intervention task.

Participant 5:

An analysis of P5's pre-intervention battery revealed three main symptoms:

a) poor verb retrieval;
b) poor noun retrieval; and
c) inability to produce all the clause elements of a sentence.

P5 could produce well structured sentences at baseline for verbs but her sentences were different from the target sentences. For example, at the baseline she produced non-target sentences such as *he likes that (*for *the woman fed the boy some yoghurt), I don't know (the woman asked the man question), it's nice of her (the man gave the woman a bottle of wine)*. P5 produced utterances such as *the cook good (the chef's meal is tempting), the man (the man's arm is hurt), making a plant of a cane (the florist's bouquet is beautiful)* at the baseline for nouns. These deficits can be linked to several probable points of failure in the sentence production process. A possibility of failure at the functional level in terms of the verb lemmas is ruled out, as her comprehension of verbs and nouns is very good. Impairment in function role assignment is not evident in her spontaneous speech. She is able to retrieve a planning frame as manifest by her ability to produce sentences with all the closed class elements but without the content words. A possibility of a failure at the positional level in terms of retrieval of the lexeme exists, because she has poor lexical retrieval for both verbs and nouns with better performance for nouns. Her responses to nouns in isolation included semantic and phonemic paraphasias but a majority of her responses were categorised as no responses (she would say 'cannot say'). During noun comprehension, her errors were close semantic distractors and she produced semantic paraphasias during noun production. These semantic errors suggest a possibility of impaired aspects of lemma processing (see chapter 4, section 4.2). Her no responses during production indicate her inability to retrieve the word form of a particular lexical item.

P5's comprehension errors and poor production indicate a problem at both the functional and the positional level, possibly at the stage of lemma representation failure and at lexeme retrieval. In the experimental intervention, P5's performance on nouns and verbs supports the locus of impairment at the functional level and the positional level.

Participant 6:

An analysis of the pre-intervention battery revealed the following deficits:

a) very poor verb retrieval;

b) very poor noun retrieval;

c) inability to produce a sentence; and

d) poor auditory comprehension.

Language data indicate a poor production and comprehension of verbs and nouns, with comprehension better than production, along with poor general auditory comprehension ability. Responses to nouns in isolation indicate a large component of errors that were close semantic distractors. The language data indicate problems at both the functional level and the positional level. Moreover, the possibility that more than one process at each of the levels is impaired is evident by his speech consisting of mainly of unintelligible utterances. P6's performance pattern supports the hypothetical locus of impairment because he did not improve in the trained set of items in any of the three intervention modules. This performance pattern relates with a locus of impairment at more than one level in terms of GEM.

The detailed analyses of the responses of the participants indicate a probable locus of impairment for each participant. Table 7.1 lists the hypothetical locus of impairment in the six participants based on the information obtained from the pre-intervention battery.

Table 7.1 Hypothetical impaired levels in GEM in the six participants in Study 1.

Participant	Processes
P1	Lexeme retrieval – positional level
P2	Lexeme retrieval – positional level + additional problem?
P3	Lemma and lexeme retrieval – Functional and positional level
P4	Disconnection between lemma and lexeme – Functional + positional levels
P5	Lemma representation failure – functional level + Lexeme retrieval – positional level
P6	Lemma and lexeme retrieval – Functional + positional levels

A detailed analysis of the pre-intervention performance patterns of all the participants indicates that P1 is impaired at only one level of the model (Table 7.1). P2 is suspected to have additional impaired processes besides lexeme retrieval. P5 has an additional probable impaired lemma representation besides lexeme retrieval. P3 and P6 have a similar locus of impairment and P4 has a different locus of impairment in terms of the process involved. The performance patterns of all the six participants are explained by their hypothetical locus of impairment.

Analysis of the pre-intervention battery results indicates that each participant has a different language profile in terms of their ability to produce and comprehend words, and to produce sentences. This heterogeneity of profiles may explain the variability of responses to the intervention among the participants though the expectation was that all participants would improve in response to the intervention. The different profiles of the participants indicate strengths and weaknesses of each participant. For example, the ability to produce a sentence structure is a strength for P1 while the inability to produce clause elements is a weakness.

7.4.2 Further considerations on performance variation

The participants' responses to the intervention task did not fully match with their performance patterns on the standard tests and on the Verb Production Battery and the PALPA. This can be attributed to several possible reasons:

a) An examination of the evaluation protocol used to recruit participants shows that their ability to repeat sentences was not tested before the intervention. Three of the participants (P3, P4 and P6) were not able to repeat a complete sentence. Therefore, it is possible that the locus of impairment analysis and the intervention, both derived from GEM, were accurate, but that the intervention itself (involving oral repetition) was inappropriate for some of the participants.

b) Three of the participants in the present study were severely impaired in their language abilities in comparison to the majority of participants reported in sentence production studies in the clinical aphasiology literature. In the clinical aphasiology literature, most of the participants have higher percentile scores on BDAE and other standard tests (e.g., Jacobs & Thompson, 2000). The present study deliberately chose subjects who needed help in producing grammatically simple sentences that were meaningful in everyday life. Therefore, it is possible that the intervention was not appropriate to target the locus of impairment in participants with aphasia who had impairment at more than one level.

c) The experimental intervention required participants to produce a specific sentence structure. It is possible that the task of producing a sentence with a particular sentence structure was too demanding for some of the participants. For example, some participants responded with an incomplete argument structure (e.g., *lady asked man* for *the woman asked the man a question*) or with a different structure (e.g., *the boots are very nice* for *the boy chose the boots*).

d) The experimental intervention scoring procedure did not account for partially correct responses. For example, P3 was not able to say anything before the intervention. In the affix module, instead of the phrase *man's arm*, he was able to say *man* but his score showed zero because of his inability to produce the complete phrase. His improvement therefore was not credited. It is possible that the scoring procedure was not sensitive to the changes seen in the participants. To overcome this limitation, the incomplete responses of the participants were rescored to take into consideration the different types of sentences produced. Rescoring of verb sentences and rescoring of noun sentences (see chapter 6, section 6.2.3) for P5 showed that she could produce a greater number of sentences than the ones originally scored by strict criteria, but the improvement was not statistically significant.

e) In the experimental paradigm, the number of sessions was "fixed" and not tailored to the responses of individual participants so that each participant had the same number of practice opportunities. Based on the findings of Best and Nickels (2000), it is speculated that the number of sessions was not enough to learn the task for participants such as P2 who started showing signs of improvement but did not maintain the effect of intervention. This would indirectly be related to the skills she had before the intervention. In P2's case, these skills may be related to her education and her occupation. P2 had primary education compared to a tertiary education for P1. P1 was a registered nurse while P2 was a housewife. Pre-morbid characteristics may play a role in the variation in the performance patterns as suggested by Hillis (1993, p. 23).

Thus, a number of reasons such as those listed above may have played a role in a variation in the performance pattern of the participants.

7.5 Lack of generalisation from production of verbs in isolation to production of target sentences

P1 was the only one who showed statistically significant changes in the production of verbs after the intervention. However, sentence production did not improve as a result of improvement in lexical retrieval for verbs. There are three possible reasons to explain the lack of generalisation.

First, the experimental task constrained participants' responses to the particular sentence structures (e.g., SVO or SVOO). If the participants did not produce the expected sentence, they did not receive credit. The results indicated that no sentences were produced, when in fact, P1 produced sentences with incomplete argument structures (e.g., *lady asked man* instead of *the lady asked the man a question*).

Rescoring the sentences and reanalyzing them as clause elements showed an increase in the production of trained items in P1. P1 was able to produce sentences with a range of simple argument structures, despite her inability to produce sentences with specific argument structures during the experiment.

The production of clause elements during the three modules of intervention varied in P1 (see figures 6.3, 6.6 and 6.7). P1 produced a few subjects, verbs and a minimal number of direct objects after the word module. For P1, improved verb retrieval was maintained after the word module for verbs but the production of other clause elements such as direct object and indirect object improved to a maximum only during the sentence module. These increases (during the sentence module) indicated that either the amount of information present in a sentence helped in retrieval of a greater number of clause elements or that practice in the retrieval of the phonological forms of the particular lexical items (during the whole of the intervention task) resulted in further improvement seen during the sentence module. In other words, P1 was not able to produce the clause elements of the target sentences after the word module indicating the lack of generalization from verb retrieval to sentence production.

Second, the task employed in Study 1 was different from tasks employed in other studies that reported generalisation from verbs in isolation to sentences. The task employed in the present study was a combination of a semantic task (i.e., a verification task) followed by a phonological task (i.e., production of the target stimulus twice). Neither the grammatical roles nor the argument structure of a particular verb was specified because the aim was to focus on the activation of the verb lemma at the functional level and evaluate generalisation from verb retrieval to sentence production. Studies that have reported a generalisation from verb retrieval to sentence production have used detailed semantic tasks to make the meaning of the verbs explicit (e.g., Marshall et al., 1998); a combination of semantic, phonological and rehearsal training (e.g., Raymer & Ellsworth, 2002) or a combination of semantic tasks and specification of the argument structure of the verb (e.g., Schneider & Thompson, 2003).

Third, the target in question and the assessment procedure used in Study 1 was different from studies that found generalisation from verb retrieval to sentence production. In Study 1, the participants were presented with the two pictures and asked to make a sentence to describe what happened in the picture. The target verb was not provided and the verb arguments were not cued. Marshall et al. (1998) found significant gains in sentence production. In the assessment task, their participant EM was asked to generate spoken sentences from provided nouns and uninflected verbs. Raymer and Ellsworth (2002) demonstrated significant improvements in production of grammatically and semantically correct sentences incorporating target verbs. Thus, in both Marshall et al. (1998) and Raymer and Ellsworth (2002), the participants were provided with the target verb or noun to form a sentence. Similarly, Schneider and Thompson (2003) found a significant improvement in constrained sentence production from pre- to post treatment. The pictures used in the constrained sentence production had the arguments of the verb identified with arrows and the participants were asked to tell what was happening in each picture in a complete sentence making sure they used all the people, places and objects marked by the arrows (Schneider & Thompson, 2003).

The finding of a lack of generalisation from verb retrieval to sentence production in the present study (Study 1) is consistent with Mitchum and Berndt's study. Mitchum and Berndt (1994) suggested two reasons for a lack of generalisation. They are:

1) Differentiation of the processes engaged in retrieving a verb to name a pictured action from the processes needed to retrieve a verb to construct a sentence.

2) Additional untreated impairments besides a verb retrieval deficit continue to result in a poor production of sentences such as a limited use of verb-related grammatical morphemes and poor surface structure realization of the logical roles of the nouns in the sentence (Mitchum and Berndt, 1994, p. 331).

These reasons given by Mitchum and Berndt would hold true for the present study because the participants in this study had an overall impaired language profile on the BDAE indicating that additional impairments besides verb retrieval may have played a role. A differentiation between the processes engaged in retrieving a verb in isolation from the processes needed to retrieve a verb to construct a sentence is consistent with Luria's (1970) differentiation of the nominative and predicative aspects of speech. Therefore, the instructions used when a participant is asked to produce a word may play an important role in the activation of cognitive processes that are used to produce the target word.

An interesting point to note is that even though P1 did not show a generalisation from verb retrieval to sentence production, P1 showed a remarkable increase in sentence production when a verb as a written clue was provided to her in the sentence production subtest of the Verb Production Battery in the pre-intervention battery. An increase in her sentence production ability on this test in the pre-intervention battery may be attributed to a difference in the task employed to elicit sentences between Study 1 and Thompson's Verb Production Battery. P1 was able to produce all the target verbs in isolation in Study 1 but when asked to produce a sentence, she was not able to do so. The task employed in Study 1 was different from the task in the Verb Production Battery because the spoken verb was not provided as a clue and arrows as in Thompson's task did not specify the arguments of the verb.

7.6 Generalisation from affix module to production of target sentences

P1 showed a significant change in the production of verb affixes and P2 showed significant change in the production of noun affixes. However, these participants did not show generalization from affix module to sentence production. Affixes are a part of the planning frame and therefore retrieval of a verb affix or a noun affix should have helped in retrieval of the whole planning frame. Regular verb affixes should help in retrieval of a planning frame more than the irregular verbs because affixes for regular verbs, unlike irregular verbs, are retrieved in the planning frame. Irregular verb affixes, in contrast, are retrieved from memory (Pinker, 1999). All noun affixes are regular and would be retrieved in the planning frame.

A lack of generalisation from affix module to sentence production in these two participants is probably the result of a combination of factors such as performance in the affix module and the ability to retrieve lexemes. P1 showed a similar production of regular and irregular verb affixes (4 of 4 regular verb affixes versus 5 of 6 irregular verb affixes). The overall impairment at the positional level in terms of retrieval of lexemes may be a cause for no increase in the production of sentences. P2 showed improvement in the production of noun affixes but had poor noun retrieval. A problem with noun retrieval may have affected P2's ability to retrieve the verb arguments and therefore may have been a reason for the lack of generalisation from affix module to sentence production. In Study 1, a comparison of the production of affixes with the production of the lexical stems for verbs and nouns indicated that words with affixes were more difficult to produce than words in isolation for P1 and P2.

7.7 Lack of generalisation from trained to untrained stimuli

In the clinical aphasiology literature, researchers have aimed for obtaining both response generalisation and stimulus generalisation (see chapter 4, section 4.6). According to Thompson (1989), response generalisation refers to an improvement seen in untrained stimuli, whereas, stimulus generalisation refers to an improvement seen in situations that differ from those in which training takes place (p. 196). In the present study, response generalisation for both verbs and nouns was anticipated based on the intervention task used (see chapter 5, section 5.8.7). In addition, the expectation that response generalisation would occur was based on studies that reported generalisation (e.g., Howard et al., 1985; Linebaugh & Lehner, 1979; Mitchum & Berndt, 1994; Schneider & Thompson, 2003) and based on the linguistic similarity of the trained and untrained stimuli (Thompson et al., 1993, 1997).

Generalisation from improvement in the trained stimuli to untrained stimuli was expected in participants who showed an improvement in the trained stimuli (i.e., P1, and P2). P1 did not show a significant increase in the production of untrained verbs, verb affixes and verb sentences as a result of the intervention. P2 did not show a significant increase in the production of untrained nouns, noun affixes and noun sentences.

Studies that have reported generalisation from trained to untrained verbs include Mitchum & Berndt (1994), Marshall et al. (1998) and Schneider and Thompson (2003). The target stimuli varied in these studies. For example, the targets were auxiliary/inflection combinations (Mitchum & Berndt, 1994), verbs from five semantic categories (Marshall et al., 1998) and verb categories based on argument structure and semantic category (Schneider & Thompson, 2003). In these studies, the extent of the generalisation achieved varied. There was generalisation to all eight sets that were not trained in Mitchum and Berndt's study. Marshall et al. (1998) found a small but not significant change in the control verbs. In Schneider and Thompson's study, only one of the seven participants showed generalisation to untrained stimuli within the verb category (p. 231) where the criterion for generalisation was an increase of 30% or better above the baseline performance.

Thompson (1989) explored the factors that could affect generalisation and of the factors listed by Thompson, one factor is relevant to the present study. The factor is the treatment method employed. In the present study, the task used was a combination of a semantic task and a phonological task with corrective feedback (see chapter 5, section 5.8.7). The intervention was comprised of modeling (e.g., an oral imitative model), and did not explicitly articulate linguistic combination rules. For example, the participant was not instructed to "add an inflection". Thus, the task in Study 1 focused on presenting the target lexeme rather than teaching the rule. In contrast, Mitchum and Berndt (1994) trained auxiliary/inflection verb combinations. They instructed the participant to describe each sequential frame using the auxiliary verb and the appropriate inflection of the main verb to denote if the action was about to happen, the action was right then or the action was already done. Therefore the focus of their intervention was a verb phrase (e.g., *is jumping, has jumped, will jump*) instead of a verb in isolation (e.g., *jump*). Marshall et al. (1998) focused on semantic tasks such as *word-picture matching* and *odd one out* to establish verb meaning followed by verb generation. Schneider and Thompson (2003) presented the individual training item followed by either a definition of the concept being trained, or argument structure and thematic role information. This difference between the task employed in Study 1 and in studies that found generalisation from trained to untrained stimuli (i.e., Mitchum & Berndt, 1994, Marshall et al., 1998, and Schneider & Thompson, 2003) could have been a reason for the lack of generalization in the present study.

Other explanations: In the present study, the trained verb lists and noun lists for the different verbs forms and noun forms were not matched in terms of the semantic complexity of the target words because the focus was on the syntactic structure of the verbs. All the verbs selected in the trained and the untrained category fall broadly into the semantic category of activity verbs. However, the verbs were not differentiated in terms of *general* versus *specific* verbs and *patient* versus *patient and state* verbs as categorized by Breedin et al. (1998). Therefore, the lack of semantic similarity could be a reason for the lack of generalisation seen from trained to untrained stimuli. Additionally, the number of trained verbs was very low. Studies that have found generalisation have trained a high number of verbs e.g., Schneider and Thompson (2003) trained 40 verbs. The present study trained only ten verbs because of the time involved for individual sessions in the intervention and the overall length of the intervention in terms of the number of sessions needed.

Changes in the post-intervention battery: Though the participants did not show a change in the production of untrained items, there was a statistically significant change in the production of some items in the post intervention battery measures for P1 and P2 (see chapter 6, section 6.4). P1 showed a significant change in scores for verb production in isolation and for direct objects produced during sentence production. The types of verbs in the Verb Production Battery can explain this significant change. Fifteen of the twenty-five verbs in the verb production (in isolation) subtest of the Verb Production Battery were intransitive or could take an optional argument in contrast to the transitive and the ditransitive verbs in the training list. The possibility here is that training complex verbs (i.e., transitive and ditransitive verbs) led to generalisation to simple verbs (i.e., intransitive verbs) (e.g., Thompson, 2003). In the literature, studies provide evidence that intransitive verbs are much easier to retrieve than transitive verbs (e.g., Thompson et al., 1997). P2 showed a change in the production of subjects in sentence production subtest of the Verb Production Battery. The sentence module trained the participant to produce a subject-verb-object and may be responsible for the change in the production of subjects. After the sentence module, P2 produced more number of subjects than before the sentence module even though the difference was not statistically significant (see chapter 6, section 6.2.2.1).

7.8 Generalisation from intervention in the three modules to spontaneous speech

The current study used five pictures to elicit a spontaneous speech sample for all the participants at the baseline, after the word module, after the affix module and after the sentence module. The post-hoc reliability results (see chapter 5 section 5.8.7.4) indicate that statistically significant variability was not seen in the normal speakers. Further tests on the data from the three participants (P1, P2 and P5) were not performed but the assumption is that the participants showed a similar pattern of variability as seen in the normal speakers. This assumption should ideally be tested.

The speech samples of P1, P2 and P5 showed changes in some of the spontaneous speech variables measured. P1 showed a change in the verb tokens and verb types with intransitive verbs showing a consistent increase unlike transitive verbs that showed a transient change after the word module. P2 showed a change in the number of nouns produced after the intervention modules. P5 showed a fluctuating increase in the nouns and verbs produced. After the sentence module, specifically transitive verbs improved to a maximum.

In P1, the statistical change in the number of verbs produced in isolation and for direct objects produced during sentence production (in the Verb Production Battery) supports the significant change in the production of trained verbs. At the same time, there was no generalisation from trained verbs to untrained verbs in the probe list. We infer this to imply that the generalisation list did not capture the change in the untrained verbs. The reason for a change in the spontaneous speech could be that the speech task did not constrain the responses of the participants in terms of the choice of verbs or the argument structure. Similarly, P2 showed a statistical change in the production of nouns, in particular, subjects during sentence production. This supports the change in the trained nouns. P1 improved on verbs during both the intervention and the post intervention battery. Similarly, P2 improved on nouns during both the intervention and the post intervention battery.

The change seen in P5 is likely to be a result of variability because she did not show any significant changes in the trained items during the intervention. Moreover, the change in the production of verbs and nouns seen in spontaneous speech was not consistent (see chapter 6, section 6.3).

7.9 What is the significance of the results for the theoretical validity of GEM?

GEM is derived from normal speech errors. The current study used GEM to articulate theoretically-motivated hypotheses and to construct an experimental paradigm. The hypotheses directly derived from the model were hypothesis 1(a), 1(b), 1(c), 1(d), 2, and 4 (see section 7.2). The intervention task chosen in the current study, though not prescribed by the GEM of sentence production, is very closely related to the model concepts in terms of the lemma and the lexeme, resulting in the selection of a combination of a semantic and a phonological task. The specific intervention tasks (verification and production), however, were not driven by the model.

This section will discuss the significance of the results of Study 1 for the model taking into consideration three main aspects. The first aspect will be the hypotheses derived from GEM. The second aspect will be the testing of GEM. The third aspect will be the implications for GEM.

7.9.1 Hypotheses derived from the GEM

The hypotheses that were supported by the performance patterns of some of the participants were 1 (a), 1(c) and 2. Regarding hypothesis 1(a), an improvement in the trained items was seen in two of the six participants. Regarding hypothesis 1(c), improvement in retrieval of nouns did not generalise to an increase in the production of targeted sentences. Regarding hypothesis 2, the experimental intervention did not result in generalisation from one grammatical class to another in any of the modules for any of the participants.

In contrast, hypothesis 1b and hypothesis 1d were not supported by the performance of the participants. Hypothesis 1b, that the activation of the verb lemma would result in activation of the argument structure at sentence level, was not supported because the participants did not show sentence production in association with the verbs that were taught in the word module. Hypothesis 1d, that an increase in the production of verb affixes and noun affixes would result in an increase in the production of targeted sentences, was not supported, because P1 and P2 did not show a statistically significant increase in the production of sentences during treatment for verb and noun affixes, respectively.

Assuming that the construct of the lemma activating the argument structure in GEM is correct in normal sentence production, why was there no generalisation from lemma activation to sentence production in P1 in this study who showed a significant improvement in the production of the trained items in all three verb modules?

The possible explanations in terms of GEM are:

a) The verb lemma retrieved in the word module did not activate the argument structure of the verb in P1.

b) The verb lemma activated the argument structure of the verb but P1 was not able to retrieve the corresponding lexemes. This possibility does not explain the performance pattern of P1 who had good noun retrieval. Sentences produced with incomplete argument structure after the word module indicate that the lemma activated the argument structure but we do not know if the information activated by the lemma was incomplete or if there was a difficulty in retrieving the lexemes associated with the arguments. P1 was able to produce subjects and direct objects for approximately 5 of the 10 verbs after the word module.

c) Mere activation of the verb lemma and the arguments is not enough to produce a sentence because there are other processes important for sentence production as proposed by the model e.g., specification of the functional and grammatical roles. Specification of the functional and grammatical roles is an essential part of sentence production – support for this comes from the mapping therapy studies (e.g., Byng et al., 1994; Schwartz et al., 1994) and the fact that the participants were able to produce a sentence when a complete sentence was presented to them.

Kim and Thompson (2000) found that subjects with agrammatism showed difficulties accessing the lemma level of representation of verb argument structure properties when conscious recall of the information was required to self-generate a verb label or a rudimentary syntactic structure i.e., in production tasks. Considering Kim and Thompson's study, it is possible that the verb lemma activated the arguments in the present study but P1 who showed features of agrammatism was not able to access the arguments. An alternative explanation is that though the information about arguments is available, P1 was not able to use the information until it was made explicit in the sentence module in the current study. The verb was presented in isolation in the word module, while the complete sentence was presented with the arguments in place in the sentence module. The presentation of a complete sentence would have made the arguments explicit in contrast to presentation of a verb in isolation (e.g., in the word module). This explanation is supported by a maximum increase in the number of clause elements produced during the sentence module. The explanation, that the patients with aphasia are not able to use information about arguments unless it is made available, is supported by studies such as Marshall et al. (1998) and Schneider and Thompson (2003) who focused on semantic tasks to make the grammatical and functional roles explicit. In addition, a possibility is that practice with the lexemes of the arguments during the intervention task in the sentence module (when the participant is asked to produce the target sentence twice) helped in retrieving the lexemes. An improvement in sentence production as a result of improved lexeme retrieval would support our hypothetical locus of impairment at the positional level in P1.

In summary, the performance patterns seen in P1 raise questions about lack of generalisation from word module to sentence module and from affix module to sentence module (in P1 and P2). There are four possible explanations for the questions raised: a) there was no activation of the verb arguments by the verb lemma, b) there was activation of the verb arguments but an inability to produce lexemes, c) there were impaired processes additional to lexeme retrieval (in P2) and d) activation of the verb lemma is insufficient to produce a sentence. However, GEM lacks the explanatory power to enable us to choose one particular answer. Therefore, we conclude that GEM is not detailed enough to explain the data of Study 1.

7.9.2 Testing of the GEM

The GEM of sentence production can be tested on two premises related to the results of Study 1.

1. The hypothetical locus of impairment derived from the baseline tests should be verified by the performance pattern of the different participants in the intervention. The study was not designed to determine a locus of impairment for the participants before the intervention or to individually mould the intervention according to the locus of impairment. However, in order to explain the performance pattern of the participants, the pre-intervention test battery in association with the GEM was used to determine the probable locus of impairment in each participant. The hypothetical locus of impairment was supported by the performance of each participant in Study 1 (see section 7.4.1).

2. Generalisation patterns of the performance in the participants as predicted by the GEM of sentence production, if seen, would provide support for the model. However, the participants did not show a generalisation from improvement during training of verbs at word level to production of sentences, and they did not show generalisation from improvement during training of verbs at affix level to production of sentences.

Thus, the locus of impairment derived from the pre-intervention test battery results of the participants was verified by the performance pattern of all participants. However, the lack of generalisation patterns seen in the participants do not provide support for the model.

7.9.3 Implications of Study 1 for GEM

In a cognitive neuropsychological (CNP) approach in aphasiology, the aim is to develop a theory of the cognitive processes required for a particular task (i.e., sentence production in this study) by examining the abilities of brain damaged individuals. The inability of GEM to explain the data in Study 1 questions whether it is appropriate to test theoretical models of normal sentence production using individuals with aphasia.

GEM is a model of sentence production that is predicted to work for the normal population. GEM appears to predict performance to a certain extent for individuals such as P1, who had relatively normal language at baseline testing but not for P5 who had impairment at more than one level. Specifically, P1 had a good baseline performance in terms of her ability to produce and understand verbs and nouns; had a preserved ability to produce a limited sentence structure and had good repetition ability. GEM predicted the performance pattern for P1 in terms of an increase in the trained items for verb modules. However, GEM did not predict the performance pattern for noun modules or a lack of generalisation from the word module to the sentence module for verbs and from affix module to sentence production. In addition, GEM failed to explain the lack of generalisation in terms of the detailed processes impaired (except for a broad impairment in lexeme retrieval at the positional level). The lack of generalisation across modules seen in most of the participants suggests that the theoretical assumptions of GEM apply only to individuals with impairment at a single level in terms of impaired process e.g., lexeme retrieval for verbs in P1. In other words, GEM fails to predict patterns for participants with additional impairments besides verb retrieval. The results of Study 1 thus imply that patients with aphasia who have a severe language profile and a poor baseline performance or impairment at more than one level of the GEM may not be appropriate subjects for model-based intervention such as the one in this study.

One of the reasons for the lack of explanation of results by GEM for Study 1 is that GEM does not take into consideration the detail of the processes taking place at each level. For example, in the process of activation of a verb lemma that in turn activates the arguments of that particular verb, we do not know how this is achieved and on testing we can only infer from what is intact or not intact in an individual. The lack of detail in the model results in defining impairment broadly in terms of lemma retrieval or lexeme retrieval. Moreover, we do not have tests that can explicitly point to the details of processes affected in an individual.

Another implication of Study 1 is that both the features of the treatment task and the level(s) of impairment need to be taken into account for a participant to respond to the intervention.

Hypotheses based on GEM did not predict the performance of participants with aphasia, such as the ones in the current study when an intervention constructed in line with the GEM hierarchy of cognitive processing was administered. Therefore, participants with impairment at more than one level of GEM may need multi-step treatment based on the impaired processes and intervention such as the one in the current study may not be appropriate. However, participants such as P1 whose impairment level matched the intervention task did not show generalisation from verb retrieval to sentence production. This implies that to produce a sentence, patients with aphasia may need more information besides the information presumed to be inherent in the presentation of a verb in isolation.

7.10 Clinical significance of results

The change in production of the trained stimuli in the current study was found to be statistically significant for only one of the participants. One of the reasons for the lack of statistical significance is the small number of items and a small number of generalisation probes administered during the withdrawal phase (i.e., three) rather than six (i.e., one in every session). After completion of the intervention for a particular dependent variable, the number of points above and below the line in the withdrawal phase was lower than the lowest number of *n* listed in the statistical table for the binomial test (see chapter 5, section 5.8.12). The lower number of probes occurred because of the decision to probe generalisation measures for three of the six variables every alternate session rather than in every session. Generalisation probes for all the six variables in every session would have resulted in the addition of at least half an hour to the existing time in every session and was not practically feasible. Unfortunately the implications of this decision for the statistical analysis did not become clear until the data analysis stage of the project. However, despite the lack of statistical significance, the results from Study 1 are of clinical significance because they inform us about the factors important for enhancing the success of a particular intervention.

7.11 Clinical implications

The results of Study 1 have three implications for clinical therapists. The first implication concerns the module important for sentence production. It is difficult to speculate on the module that will result in a maximum improvement in sentence production from the results of Study 1. A point to bear in mind is that the effect of intervention in the sentence module is a combined effect of the word module, the affix module and the sentence module because verbs, nouns, verb affixes and noun affixes used in the target sentences have already been trained in the earlier modules (i.e., the word module and the affix module). To be able to specify one module that is most effective, it would be essential to counterbalance the order of presentation of the three different modules because despite the multiple baseline design, we do not know if the sentence module by itself would result in the same response as in Study 1.

However, the present study does suggest that to achieve generalisation to sentence production, it is important to train at sentence level (i.e., verbs in sentences) along with verbs at word level (i.e., in isolation) because there was no generalisation from word module to sentence production. The specific effect of training with the sentence module alone needs to be explored to evaluate whether it is also necessary to train at word level to improve sentence production.

The second implication is that the success of an intervention such as the one in Study 1 is directly related to the baseline performance of participants with aphasia. The present study tells us that the skills that a participant has in terms of comprehension, repetition and production may be very important in determining the success of an experimental intervention. This would correspond to the patients' skills *a, b, c* in Best and Nickels' equation of a successful outcome (Best & Nickels, 2000). Furthermore, in terms of a model of normal sentence production such as GEM, Study 1 tells us that participants with a hypothetical locus of impairment at more than one level (e.g., P2 and P5) may have a poorer outcome in comparison to participants with a probable impairment at only one level (e.g., P1).

7.12 Implications of Study 1 for further research

A lack of generalisation from training verbs at the word module to production of target sentences raised questions about the process of verb lemma activation. The main question that was raised by the results of Study 1 was: *Does the lemma of a verb activate the argument structure of that particular verb in patients with aphasia (as in normal speakers)?* That is, if the verb lemma is unable to activate the argument structure of a particular verb in patients with aphasia, then will providing the argument structure result in improved sentence production? This question is asked in Study 1A that will be described in Chapter 8.

7.13 Conclusion

Study 1 suggests that the different modules of the experimental intervention (i.e., word module, affix module and sentence module) are essential in the construction of a sentence but they are not sufficient. In terms of the questions asked in section 7.3, we conclude the following based on the results obtained in Study 1:

1) Intervention in each module resulted in improvement in the trained items in that particular module in P1 and P2. The improvement in the trained items implies that a combination of a semantic and a phonological task helps in strengthening the association between the lemma and the lexeme.
2) There was no generalisation from improved verb retrieval to production of sentences using those verbs. The lack of generalisation from verb retrieval to sentence production may reflect the influence of

additional factors such as poor noun retrieval, and the constrained sentence structure used in the intervention.

3) A lack of generalisation from improvement in verb affixes and noun affixes to sentence production may be due to a combination of performance in the affix modules and poor lexeme retrieval.
4) Evidence of a lack of generalisation from trained to untrained stimuli of a similar type may be related to the way the intervention was constructed and/or the small number of stimuli trained.
5) Evidence of a lack of generalisation among different grammatical classes supports the suggestions from other studies (e.g., Miceli et al., 1984; Zingeser & Berndt, 1990) that verbs and nouns as stored in the semantic lexicon do not share the processes used to retrieve them.

Chapter Eight: Study 1A

8.1 Introduction

The main study (Study 1, see chapters 5 and 6) focused on testing the validity of GEM (Grammatical Encoding Model, see chapter 3, section 3.7.1) by providing experimental intervention at three different linguistic levels (word level, affix level and sentence level) referred to as intervention modules.

The findings of Study 1 raised a question about activation of the argument structure: *Does the lemma of a verb activate the argument structure of that particular verb in patients with aphasia (as in normal speakers)?* The most probable answer to this question is *no*. A negative answer to this question is based on the findings in the main study where the participant (P1) who benefitted from the verb word module did not show generalisation from intervention in the word module to retrieval of argument structure and production of a targeted sentence at the sentence level, a finding that was inconsistent with the GEM. This finding was confirmed even in one of the participants who had relatively good language abilities in terms of auditory comprehension, repetition and naming.

The lack of generalisation from the verb in isolation to the verb at sentence level is explained by two main possibilities: a) the activation of the lemma did not activate the argument structure (i.e. the grammatical structure of the verb in terms of the clause elements required) for that particular verb in patients with aphasia; or b) the participants were not able to retrieve the word forms of the arguments of the target verb (see chapter 7, section 7.5). The second possibility does not hold true for patients with good verb and noun retrieval abilities as their good retrieval abilities indicate that such patients are able to retrieve the word form.

Let us go along with the first possibility, i.e., the activation of the verb lemma did not activate the argument structure and consider what happens if the participants are provided with the verb and the verb arguments. The next question that is raised is:

If a participant is presented with the verb and its arguments, will the participant be able to produce a SVO (subject-verb-object) or SVOO sentence structure depending upon whether the verb is a two-place (e.g., *the woman grated the carrot*) or a three-place verb (e.g. *the man gave a bottle of wine to the woman*)?

8.2 Study outline

Study 1A was designed to evaluate the effectiveness of an experimental intervention focusing on verbs and the arguments of those verbs on sentence production in patients with aphasia. Based on the results of the main study, it is speculated that the participants in the main study were not able to produce sentences after intervention in the word module because they were not able to retrieve the argument structure of that particular verb. Thus, if our speculation is correct, then providing that missing information in the form of verb arguments to the participant should result in production of a sentence using that verb and the provided arguments. Though only the verb arguments were presented without specifying their functional and the grammatical roles, the syntactic structure of the verb was implicit because the arguments were presented in one order only.

8.3 Aim of the study

- To examine changes in sentence production in patients with aphasia as a result of an experimental intervention that provides a verb and the verb arguments. Providing the verb and the arguments of that verb corresponds to the functional level and the positional level of GEM.

8.4 Experimental intervention

The emphasis of the experimental intervention was on retrieval of the arguments of a verb during sentence production. To enhance the retrieval, verbs along with their arguments were presented to the participants. Only one module of intervention was proposed that targets specification of arguments of a verb at the functional level and retrieval of their word forms at the positional level. This module will be called the verb argument module. Thus, patients with impairment at the functional level (in terms of verb lemma activation) or the positional level (in terms of retrieval of lexemes) or both should be able to produce sentences using the information provided.

8.5 Hypotheses and predictions

8.5.1 Hypothesis 1

An experimental intervention that provides the verb and the verb arguments will result in an increase in the production of target sentences in patients with aphasia.

An increase in production of sentences is predicted based on the main study where the participants were able to produce sentences with incomplete argument structures for a particular verb when asked to produce a sentence. Providing the arguments of a particular verb will make the arguments available to the participant and should result in an improved structure for the sentence.

8.5.2 Hypothesis 2

An experimental intervention focusing on the verb and the arguments of that verb will result in an increase in the production of untrained sentences that are linguistically similar to the trained sentences.

Generalisation to untrained linguistically similar sentences is expected because of two main reasons: a) activation of the same process in both trained and untrained verbs, and b) linguistic similarity. First, specification of the arguments in the trained verbs should focus the participant's attention on similar aspects of the pictures for untrained verbs resulting in activating the process of argument specification and formation of a sentence structure. Second, the verbs are represented in the lexicon based on the argument structure (see chapter 4, section 4.2.1.4) increasing the chances of activation of linguistically similar items. In Study 1, though no generalisation was found based on linguistic similarity, generalisation is expected in Study 1A because untrained verb sentences will use the same process that have been activated for/by the trained verbs.

8.5.3 Hypothesis 3

An experimental intervention focusing on the verb and the arguments of that verb will result in an improvement in spontaneous speech (i.e., an increase in the number of verb types and their respective arguments produced) as a result of the intervention. An increase in the number of arguments will be measured as an increase in the types of verbs produced (e.g., transitive, ditransitive) after the intervention.

8.6 Study design and methodology

A single subject experimental withdrawal (ABA) design was used in Study 1A. A single subject withdrawal design was chosen because the clinical research question was to evaluate the effect of the experimental intervention on sentence production relative to no treatment. The independent variable was the experimental intervention. The target behavior i.e. the dependent variable was sentence production (defined as production of the verb and the arguments associated with that verb in a sentence). The intervention targeted only one linguistic level i.e., sentence level. In addition, verbs with past affixes were baselined to evaluate the generalisation of intervention from production of sentences to the production of verbs with affixes. Verbs with affixes were not trained at any stage in the study. There is no elicitation of verbs in isolation i.e., at the word level in this study. Verbs were probed at the sentence level (during treatment probe) and at the affix level (during generalisation probe).

The overall structural design of Study 1A was the same as in Study 1. The aspects similar to Study 1 were the inclusion and the exclusion criteria, the evaluation protocol and the pre- and post-intervention battery (see chapter 5, section 5.8).

Materials: A total of 20 verbs were selected for Study 1A. Of the 20 verbs, 10 were selected for training and 10 were selected for testing generalisation. Seventeen of the twenty verbs that formed the untrained category in the main study were chosen because no generalisation to untrained verbs had been found for any of the participants in the main study. The reason for a change of verbs was that two of the verbs in Study 1 were not ditransitive as categorised earlier but were transitive verbs with an adjunct (see chapter 5, section 5.8.5). These two verbs (*hang, take*) were deleted from the proposed list for Study 1A and two new verbs (*find, bake*) were added.
One additional verb was replaced (i.e., *tell* replaced by *dry*) to equalise the number of verbs in the transitive and ditransitive category. The picture for the verb *hold* was changed, as the action depicted in the picture was ambiguous because it elicited verbs such as *give, hand.* Three different verbs were selected to make a total of twenty verbs. The new verbs were *find, bake* and *dry*. Table 8.1 presents the verbs in the trained category and the untrained category used in this extension. The pictures used for the verbs at affix level and at sentence level are presented in Appendix A.

Table 8.1 List of verbs in the trained and the untrained category. Verb frequencies for the lexical stem in written English are in brackets. The verbs in bold are different from Study 1.

Regular	**Irregular**	**Sentence**
Trained		
Transitive		
Wipe (10)		The woman wiped the board
Chop (3)		The woman chopped a pepper
Assemble (9)		The woman assembled the lamp
	Break (88)	The woman broke a stick
	Hold (169)	The woman held the baby
Ditransitive		
Wash (37)		The woman washed a t-shirt for the boy
Organize (14)		The mother organized a birthday party for the boy
Offer (80)		The woman offered the man a biscuit
	Buy (10)	The father bought boots for the boy
	Read (173)	The woman read a book to the boy
Untrained		
Transitive		
Share (98)		The couple shared a drink
Sort (164)		The woman sorted the money
Dry (68)		The woman dried her hands
	Make (794)	The boy made a castle
	Find (399)	The boy found a truck
Ditransitive		
Serve (107)		The waiter served them the dessert
Show (287)		The woman showed the man some photographs
Bake (12)		The grandmother baked a cake for the boy
	Build (86)	The woman built a tower for the boy
	Send (74)	The woman sent her friend a letter

8.6.1 Procedures

8.6.1.1 Baseline procedure

A baseline was obtained for verb sentences (i.e., sentence level) for each participant. In addition, baseline testing was done for the production of verbs with past affix so that generalization could later be tested. The number of sessions and the procedure for obtaining the baseline was the same as Study 1 (see chapter 5, section 5.8.7). Two practice items were used to familiarise the participants with the task. The mouse was used to point to the different parts of the picture during the practice items but not during baseline testing.

8.6.1.2 Experimental intervention

The verb argument module targeted the functional level and the positional level of the GEM. The intervention involved providing participants with the verbs and the arguments of that particular verb that activated the functional level of GEM. This was followed by providing the target sentence and asking the participant to repeat the sentence twice, thus activating the positional level.

Steps: Two practice items were used to explain the whole procedure to each participant. The detailed steps of the intervention task are presented below.

The specific instructions to each participant were:

Look at this picture. I will give you three words and you will be asked to make a sentence using all the three words, for example, here is a picture, the three words are break, woman, stick (pointing simultaneously with the mouse to the words that were said). Target sentence: *The woman broke the stick.*

Step 1: Present the picture and say *break, woman, stick* and simultaneously point to the action and the items/people in the pictures with the mouse cursor.

Step 2: Ask the subject to make a sentence.

Step 3: Provide the subject with corrective feedback (*Correct/Incorrect*) and the target sentence irrespective of whether his response is correct or incorrect (e.g., Correct, the sentence is *the woman broke a stick*).

Step 4: Ask the subject to repeat the sentence twice irrespective of the fact if the subject's version is correct or incorrect. No grammatical and functional roles were discussed or explained.

During the intervention, participants' responses were also noted after Step 2 to see if mere presentation of the verb and the arguments (i.e., stimulation of the functional level in terms of arguments only) would help in the production of a sentence.

Scoring: The responses of the participants were scored in a similar manner to Study 1 (see section 5.8.7.3). At the baseline, the number of correct sentences produced was recorded. A sentence was scored correct if the sentence had all verb arguments present. Similarly, the number of correct sentences produced was recorded during the intervention and the withdrawal session. Utterances were rescored taking into account the relevance in relation to the picture and the information expressed (e.g., *chopped the pepper* was scored correct for *the woman chopped the pepper*). In addition, utterances were rescored in terms of the number of clause elements produced (e.g., subjects produced, verbs produced, direct and indirect objects produced). In the generalisation probe for verbs with affixes, the number of correct verbs produced with affixes was recorded.

Number of sessions: A detailed session outline is presented in Table 8.2. Six intervention sessions were chosen to make the number of sessions in this intervention consistent with the number of sessions in the main study. This consistency in the number of sessions would help in comparing between the word module for verbs in Study 1 to the verb argument module in Study 1A. A comparison of the effect of the word module and the verb argument intervention would help in evaluating the importance of providing the verb arguments during the intervention.

Order of presentation of verb arguments: The verb was presented first followed by the agent, recipient and/or goal depending upon whether the verb was transitive or ditransitive. Ideally, counterbalancing the order of presentation for transitive and ditransitive verbs would require 12 patients. However, no counterbalancing was done because of lack of availability of sufficient subjects.

Spontaneous speech sample: A spontaneous speech sample was elicited before and after the intervention to examine changes, if any, in the spontaneous speech of the participants. The number of speech samples obtained was two unlike four samples obtained in Study 1.

Maintenance probes: The aim of this study was to evaluate the effect of the presentation of arguments on sentence production. The verb sentences were probed a week after the intervention to see the level of maintenance (session 14).

Generalisation measures: Probes for generalisation to untrained stimuli were administered in every session during intervention. The procedure used to measure generalisation was the same as the baseline procedure, i.e., each participant was asked to make a sentence to describe what the person did in the picture. In addition, verbs with affixes were probed regularly to see if they improved automatically due to the treatment of verbs and arguments in the verb argument module.

Control probe: Ten items from the Test of nonverbal intelligence (TONI) were used as a control probe, as in Study 1. A control probe was used to see if the changes seen after the experimental intervention were due to any other extraneous variables (like spontaneous recovery or motivation) besides the experimental intervention. The control probe was not expected to improve. In Study 1A, the control probe was administered before the intervention and after the intervention. This resulted in only two measurements of the control probe unlike four measurements of the control probe in Study 1.

Data analysis: The statistical methods used in the main study were used in Study 1A. The single subject data was analysed using visual analysis and a celeration line with a binomial test. Significance of changes in the number of clause elements produced and in the pre- and post-intervention battery results was tested using McNemar's test. McNemar's test was done using statistical software SPSS 12.0. The level of significance chosen for this study is $p<0.05$.

Table 8.2 Session outline for the different phases of Study 1A.

Phase	Number of sessions	Content
Pre-intervention battery		
Baseline	1-5 (Week 1 and 2)	Baseline testing for the production of 1) verb sentences, and 2) verbs with affixes.
Intervention	6-11 (Week 3 and 4)	1) Intervention steps 1-4 (see section 8.6.1.2) 2) treatment probe 3) generalisation probe in each session. Responses of the participants were also recorded after step 2 to see the production of the sentence structure.
Withdrawal	12-14 (Week 5)	Testing of 1) trained verb sentences 2) untrained items (verbs with affixes and verb sentences) after the withdrawal of the intervention 3) maintenance probe for verb sentences in the last session (i.e., session 14).
Post-intervention battery		

Design differences between Study 1 and Study 1A: Study 1A was different from Study 1 in four main aspects:

- Linguistic levels: Verbs were probed at two linguistic levels: the sentence level and the affix level.
- Verbs: Three verbs were replaced in the list of untrained verbs (Study 1). Ten verbs were used for training and ten for testing generalisation.
- Types of trained stimuli: The focus was on verbs and therefore no nouns were trained.
- Intervention modules: There was only one intervention module, referred to as verb-argument module. The intervention targeted the sentence level.

8.6.2 Participants

Recruitment: The aim of the recruitment was to take four volunteers, two new (i.e., who had not been a part of Study 1) and two old participants (i.e., who had been a part of Study 1). Two new subjects fit the inclusion criteria of good comprehension and poor sentence production ability. P1 and P2 of Study 1 volunteered to participate in Study 1A resulting in a total of four participants, as proposed. Two new subjects were included to see if the verb argument module would produce a similar effect (as in old participants) in participants who had not been exposed to Study 1.

Personal characteristics: All four participants had a history of chronic aphasia. The time post onset in these four participants ranged from 17 months to 24 months. Table 8.3 describes the personal characteristics of the participants.

The four participants were administered the evaluation protocol. They had poor sentence production ability, good comprehension, a reliable *yes-no*, good cognitive abilities and good hearing. Participant 1 (P1) had mild to moderate apraxia as tested by the Apraxia Battery for Adults (ABA, Dabul, 1979). None of the participants had a documented history for a psychiatric disorder, dementia, mental retardation, severe dysarthria or severe oral-verbal apraxia. All the participants had received some form of speech-language treatment at the acute stage of their stroke. None of the participants were involved in any other treatment during the course of this study. The old participants were named P1 and P2 as in Study 1 and the new participants were named P7 and P8.

Table 8.3 Personal characteristics of the four participants of Study 1A.

Participant number	Age	Sex	Education	Etiology	Months post onset
P1	77	F	Registered nurse	Left MCA infarct	24 months
P2	71	F	Primary school	Left parietal lobe infarct	24 months
P7	77	F	High school	Left CVA	17 months
P8	75	M	Primary school	Left CVA	22 months

8.6.3 Pre-intervention battery scores

Scores of the four participants on the different tests of the pre-intervention battery are presented in Table 8.4. The pre-intervention battery was re-administered to P1 and P2 because seven months lapsed between the completion of the intervention for Study 1 and the start of intervention for Study 1A. In addition, P1 had personal issues before Study 1A that may have affected her performance.

8.6.3.1 BDAE

P1's spontaneous speech during the description of the cookie theft picture was good in structure (e.g., *watch her children, who is running over the sink?*) but the total number of utterances produced was low. Her speech indicates that she retains some of the improvement seen in spontaneous speech after Study 1. P2's speech during the description of the cookie theft picture indicated that the number of nouns produced (e.g., *cookie jar, lady*) was more than the verbs produced. She still produced stereotypes such as *here beside me* as in Study 1. Scores of P1 and P2 during pre intervention testing in Study 1A are different from the scores obtained for BDAE during post-intervention battery testing of Study 1. Compared to the post-intervention scores, P1 has lower percentile scores for fluency, auditory comprehension, conversational speech and naming but had higher scores for repetition. P2 had lower scores for repetition and naming but higher scores for auditory comprehension and conversational speech. A difference in scores is most likely due to variability in performance.

P7's social responses were good. P7's speech indicated some sentence structure but poor noun retrieval (e.g., *more the girl is washing the*). P8's speech indicated that he had good sentence structure but poor noun retrieval and verb retrieval (e.g., *he had a, a little girl and the boy with a naughty jar*).

8.6.3.2 Verb Production Battery

P1 was able to produce verbs (63%) and had a good comprehension of verbs (100%). The test of sentence production skills involved a written clue (for the verb) and she was able to produce verbs better than subject and direct or indirect object. Her performance on the Verb Production Battery was poorer than that during post-intervention battery in Study 1 for the majority of the measures except production of verbs during sentence production.

For P2, verb production was poor (26%), in contrast to her comprehension (92.5%). In sentence production, she was able to produce mainly subject (24/33) and verbs (19/33). The responses of P2 were better than her scores during the post-intervention battery in Study 1 on all measures of the Verb Production Battery.

P7 had a good verb production ability (85%) that was evident during sentence production (100%) and the utterances produced consisted mainly of direct objects and verbs. She had very good verb comprehension (100%). P8, on the other hand had a poor verb production (15%) that was better during sentence production. His sentences mainly consisted of a subject and a verb. His verb comprehension was good.

Table 8.4 Language test data for the four participants in Study 1A. Scores for the BDAE are in percentiles. For the Verb Production Battery, the sentence comprehension test and the PALPA subtests, the scores presented are raw scores.

Test	P 1	P2	P 7	P8
Short form of the Boston Diagnostic Aphasia Examination (BDAE)				
Fluency	20	20	30	50
Conversational Speech	50	50	100	60
Auditory Comprehension	50	35	50	60
Repetition	60	35	30	20
Naming	70	15	50	40
Verb Production Battery				
Verb production (27)	17	7	23	4
Verb comprehension (27)	26	25	27	27
Sentence production				
Subject (33)	6	24	7	15
Direct object (23)	7	7	16	6
Indirect object (8)	2	0	1	0
Verb (33)	27	19	33	23
PALPA (Subtest 47 and 53)				
Spoken word-picture matching (40)	33	34	40	39
Spoken picture naming (40)	37	12	19	21
Sentence comprehension				
A (20, active)	10	13	12	10
P (20, passive)	13	5	12	12
SR (20, subject relative)	15	7	14	10
OR (20, object relative)	10	11	11	10

8.6.3.3 PALPA subtests

Scores on the PALPA subtests showed that P2, P7 and P8 had relatively better comprehension than production of nouns. P1 had a relatively better production of nouns (92.5%) than comprehension. P1's response on PALPA subtests was poorer than during post-intervention testing in Study 1. P2's response was better on subtest 47 and the same for subtest 53 in comparison to the scores obtained during the post-intervention testing in Study 1.

8.6.3.4 Sentence comprehension

The sentence comprehension test showed that P1 could comprehend subject relative sentences (75%) but performed at chance level for the other types of sentences (active, passive, object-relative). Her sentence comprehension was similar to her responses during the post-intervention test battery in Study 1. A similar performance pattern at chance level was seen for P2. P7 comprehended subject relative sentences (70%) but performed at chance for the rest of the sentences. P8 performed at chance level.

8.7 Results – Experimental intervention

The results of the intervention (i.e., verb argument module, see section 8.6.1.2) will be discussed in this section. A particular intervention session involved the complete intervention task (step 1 to step 4), a treatment probe and a generalisation probe (see Table 8.2). During the intervention, each participants' response was recorded after step 2 (when the verb and its arguments were presented and the participant was asked to produce a sentence). This is depicted as *facilitation* on single subject graphs. The number of correct sentences produced during the treatment probe is depicted as *trained* sentences. The number of correct sentences produced during the generalisation probe is depicted as *untrained* sentences. The single subject graphs presented include four different phases: baseline, intervention, withdrawal and maintenance to illustrate the effect of the experimental intervention (i.e., the verb argument module) on trained and untrained sentences. Results for each participant will be presented in turn.

Control probe: There was no change seen in the control probe for any of the four participants indicating that the change seen in the production of sentences may be a result of the experimental intervention. There were only two measures for the control probe and therefore the lack of change in the control probe is not illustrated in the graphs.

8.7.1 Participant 1 (P1)

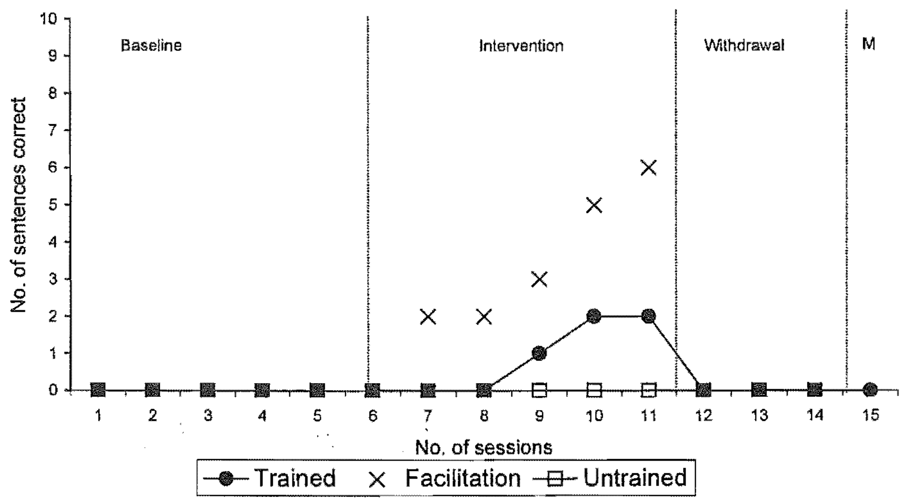

Figure 8.1. P1: Session-by-session data record for trained and untrained verb sentences. This figure shows the production of trained sentences during the different phases: baseline, intervention, withdrawal and maintenance. In addition, responses after Step 2 of the intervention are depicted in the graph as facilitation.

Figure 8.1 shows the effect of intervention on the production of trained and untrained sentences in P1. P1 was not able to produce any sentences at baseline. Facilitation of sentence production as a result of providing the verb and the arguments was seen as an increase in the production of sentences. The number of sentences produced increase from zero to six as a result of facilitation. As a result of the verb argument module, the change in the production of trained sentences was not statistically significant, though P1 was able to produce two more sentences than at baseline. There was no change in the production of sentences in the untrained category as a result of the intervention. A comparison between the responses after step 2 and the complete intervention indicates that a greater number of sentences was produced after step 2 than after step 4. However, this probably occurred because the facilitation results were noted immediately after each verb and its arguments were provided to the participant, whereas the effect of the total intervention was not probed until the very end of each treatment session. The improvement seen in the production of trained sentences as a result of the intervention in P1 was not maintained.

Changes in sentence structure: At the baseline, P1 produced utterances such as *boy and shirt, had coffee*. After the verb argument module, P1 was able to produce only two complete sentences with the correct grammatical structure (Figure 8.1). Reanalysis of P1's responses taking into consideration the relevance of the utterance produced to the picture and the explicitness of meaning, indicated that she was able to produce six of the ten stimulus pictures. Examples of her utterances include *wash a shirt for the boy* (*the woman washed a shirt for the boy*), *refused a biscuit* (*the woman offered the man a biscuit*). During withdrawal, examples of utterances for the same target sentences include *lady wash boy, refused a cake*. The increase in the number of trained sentences produced and appropriate utterances after rescoring was statistically significant using McNemar's test ($p = .016$, 1-tailed).

Clause elements produced at sentence level: In terms of clause elements, the trained sentences had 10 subjects, 10 verbs, 10 direct objects and 5 indirect objects. The untrained sentences had a similar number of clause elements. Although she could not produce sentences, P1 could produce a few exemplars of clause elements such as verbs and subjects at baseline. As a result of the intervention, an increase in the production of direct objects was statistically significant ($p = 0.08$, 1-tailed) for trained sentences (Figure 8.2). For untrained sentences (Figure 8.3), none of the changes in the production of any of the clause elements during the verb argument module were statistically significant.

Production of verbs with affix: The participants were probed for the production of verbs with affixes after each intervention session to evaluate the effect of verb argument module on the production of verbs with affixes. The verbs with affixes were not trained directly. P1 had a poor production of verb affixes at the baseline. Production of verbs with affixes did not improve as a result of the experimental intervention for sentences in P1 (see Figure 8.4).

Generalisation: No generalisation was seen to untrained sentences in P1 (Figure 8.1). The utterances she produced for the untrained stimuli included two types: utterances

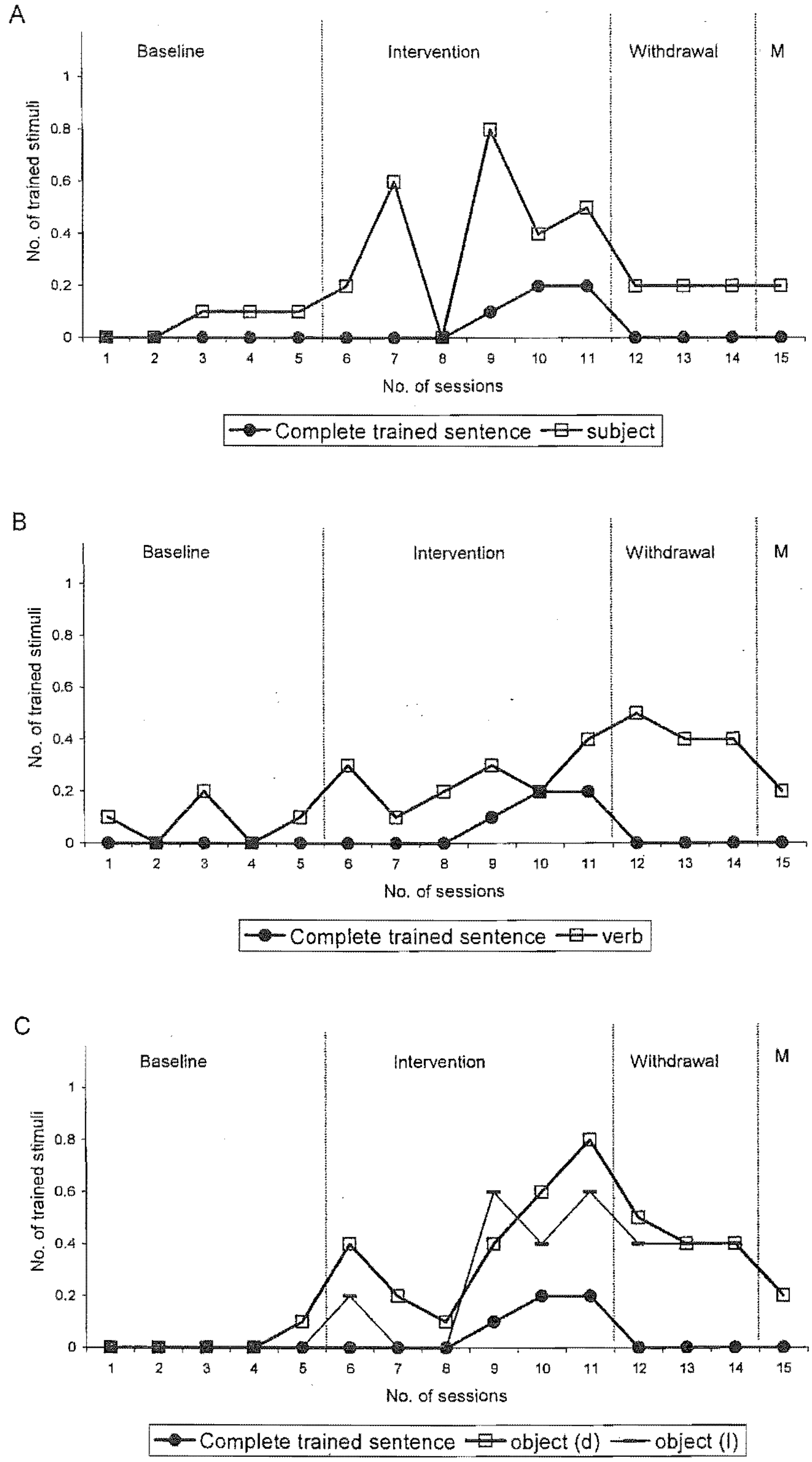

Figure 8.2. Comparison of the number of trained verb sentences and the clause elements produced in P1. Panel A shows the comparison between sentences and the subjects produced, Panel B shows the comparison between sentences and the verbs produced, and Panel C shows the comparison between sentences and the objects produced.

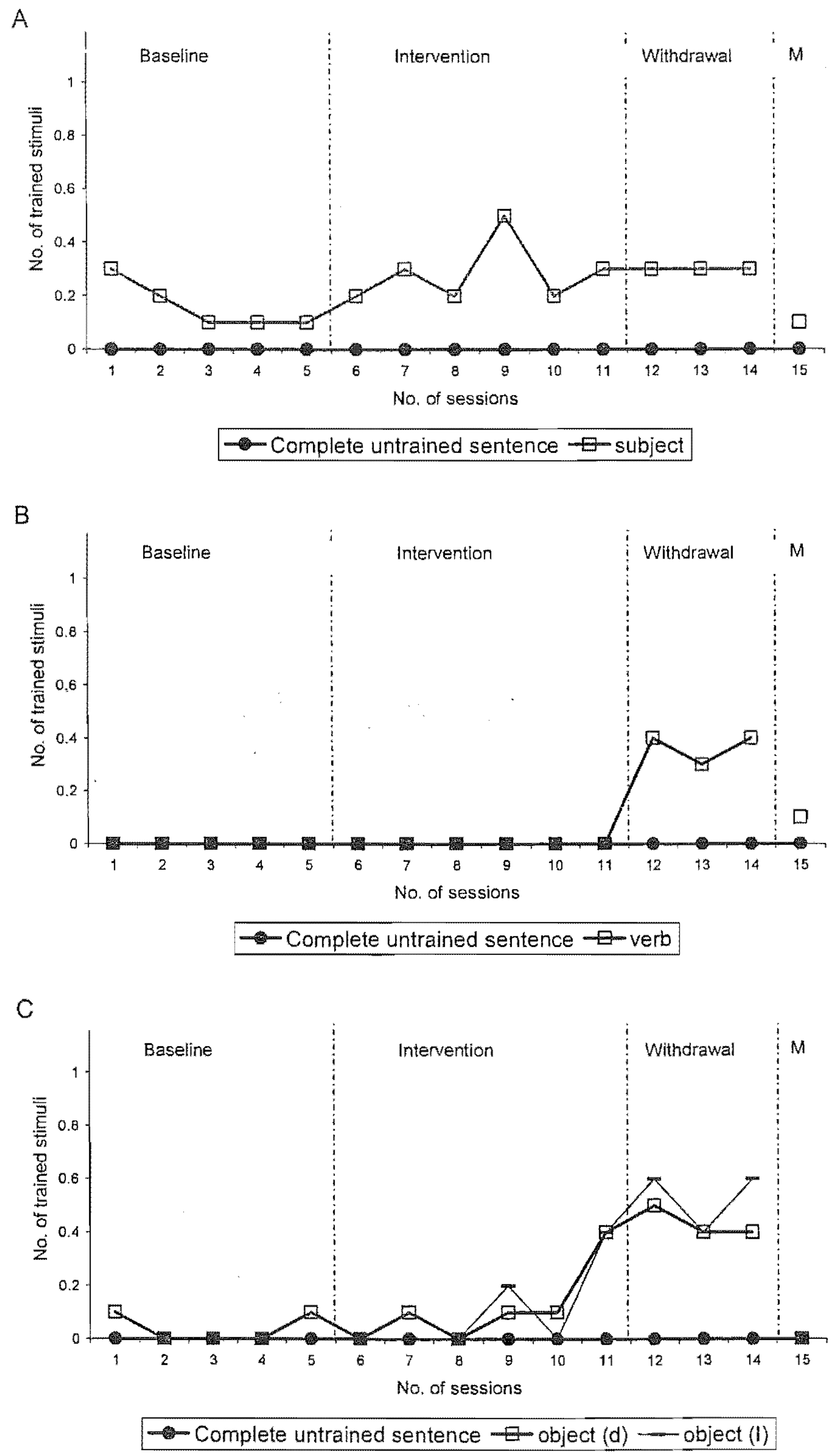

Figure 8.3. Comparison of the number of untrained verb sentences and the clause elements produced in P1. Panel A shows the comparison between sentences and the subjects produced, Panel B shows the comparison between sentences and the verbs produced, and Panel C shows the comparison between sentences and the objects produced.

with light verbs and pronouns such as *do it break* (for *the boy made a castle*), and utterances with verbs and nouns relevant to the picture such as *postmistress check the mail* (for *the woman sent her friend a letter*). She produced four utterances of the first type and three utterances of the second type. The second type of utterances was scored as correct. This production of utterances during the intervention was in contrast to the production of single words such as *do* and *postmistress* at the baseline. The number of untrained utterances produced was not statistically significant. No generalisation was seen to untrained verbs with affixes.

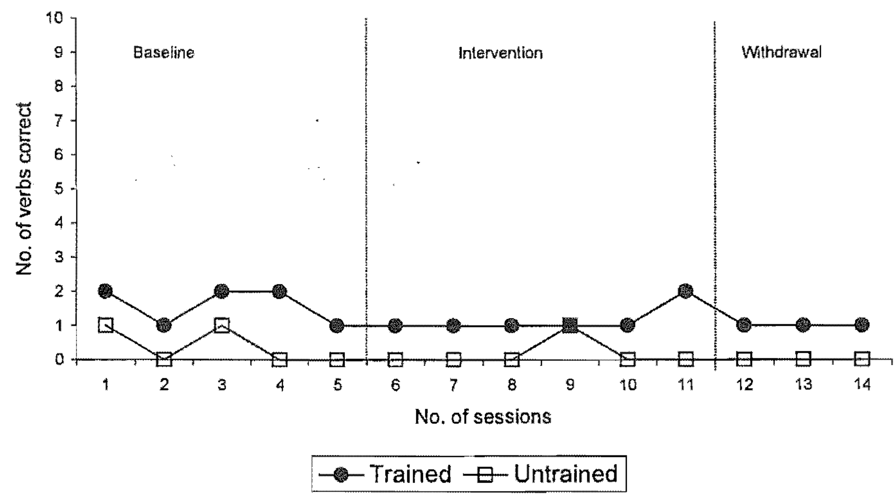

Figure 8.4. P1: Session-by-session data record for verb affixes.

Summary: P1 showed a statistically significant change in the production of trained sentences after the experimental intervention. The verb affixes did not show a change after the intervention. In addition, the increase in the production of direct objects for trained sentences was statistically significant.

8.7.2 Participant 2 (P2)

P2 was not able to produce any sentences at baseline. For P2, neither the trained nor the untrained sentences improved as a result of the intervention. No facilitation of sentence production was seen as a result of providing the verb and the arguments. P2 did not show any improvement in production of trained sentences, thus no maintenance was seen.

Changes in sentence structure: At the baseline, the only relevant utterances she produced were *lady* and *gumboots*. In the last session of the intervention, she produced one- word utterances that were the verb (e.g., *chopping*) or one of the verb arguments (e.g., *table lamp, biscuits*). During the withdrawal session, she produced utterances such as *lady hold the, biscuits and lady, lady washed shirt*. Only the utterance *lady washed shirt* was rescored as correct.

Clause elements produced at sentence level: At baseline, P2 was able to produce clause elements such as subjects and direct objects but could not produce any verbs. As a result of the intervention, P2 showed an increase in the production of subjects (Figure 8.5, Panel A) that was statistically significant ($p = .031$, 1-tailed). There was no change in the number of direct objects and indirect objects (Figure 8.5, Panel B). The only time that P2 produced a verb was in session 11 and session 14, and then she only produced one. For untrained sentences, P2 was able to produce a few subjects and direct objects at the baseline. None of the clause elements changed in the positive direction.

Production of verbs with affix: P2 showed a non-significant change in the production of verbs with affixes as a result of the intervention for sentences, from a value of zero to a maximum of two (Figure 8.6).

Generalisation: No generalisation was expected in P2 because she did not produce any sentences during the intervention.

Summary: The experimental intervention did not result in a change in the production of the trained verb sentences. The increase in the number of subjects produced for trained sentences was statistically significant.

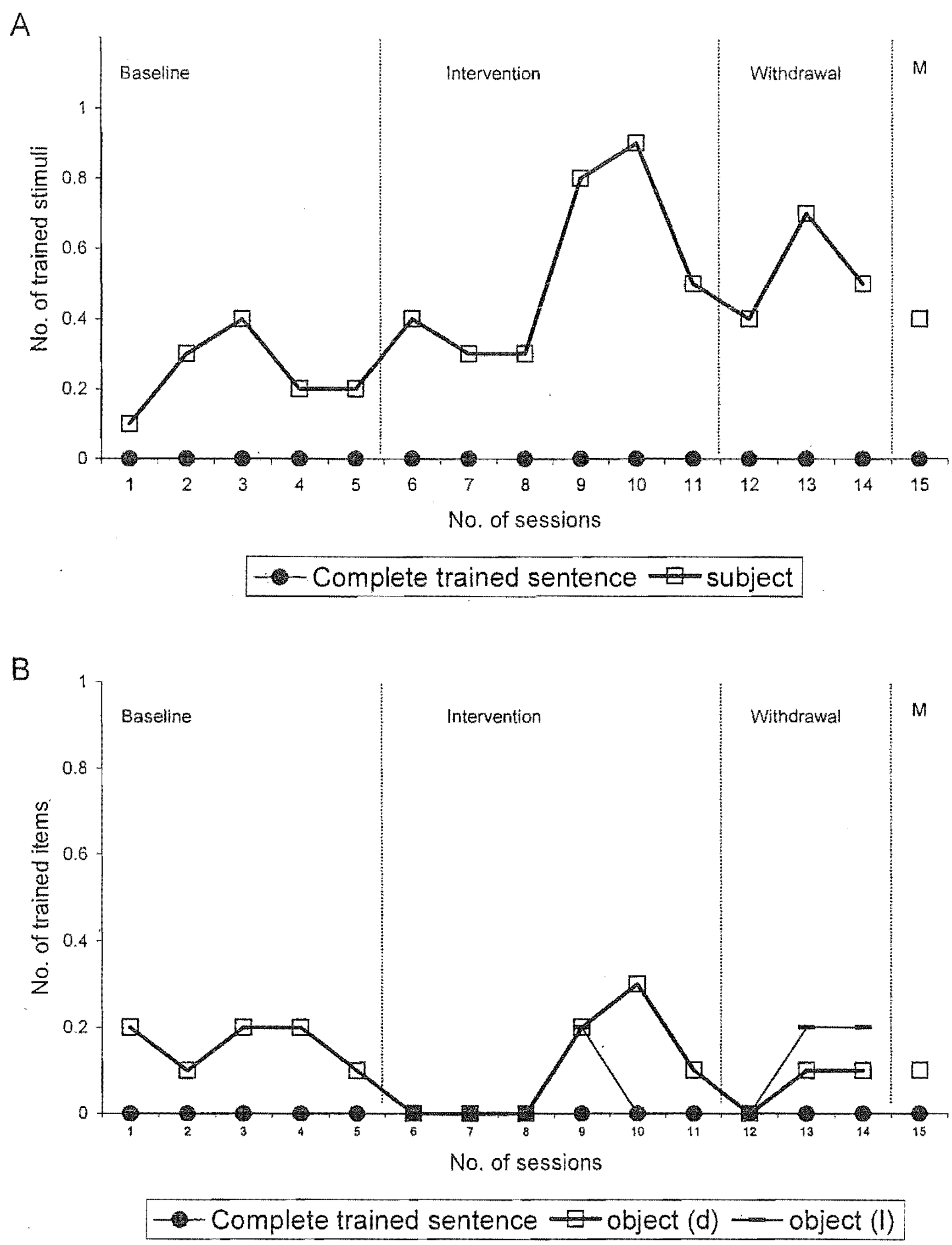

Figure 8.5. Comparison of the number of trained verb sentences and the clause elements produced in P2. Panel A shows the comparison between sentences and the subjects produced, Panel B shows the comparison between sentences and the objects produced.

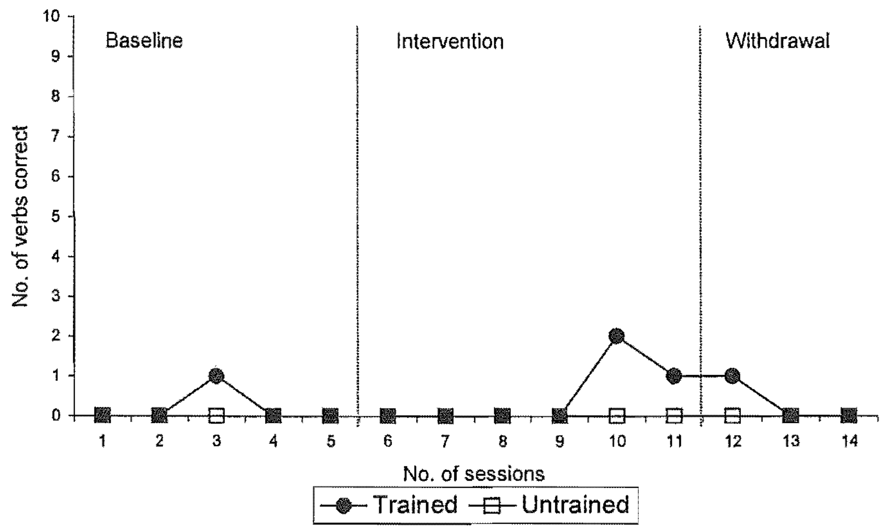

Figure 8.6. Session-by-session data record for verbs with affixes for P2.

8.7.3 Participant 7 (P7)

P7 was not able to produce sentences at baseline as seen in Figure 8.7. As a result of the intervention, P7 showed a change in the number of sentences produced. Her score changed from zero to a maximum of three in the last session of the intervention. A facilitation effect on sentence production was also seen as a result of providing the argument structure. This change in her production of sentences as a result of the intervention was found to be statistically significant ($p<0.05$) using a celeration line and binomial test. The maintenance of verb sentences was at a lower level than that seen during the intervention.

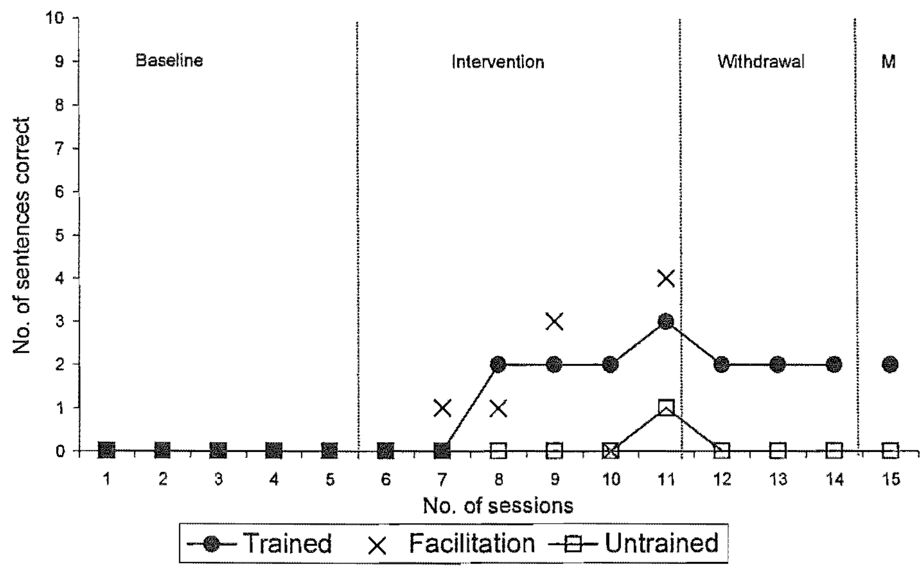

Figure 8.7. **P7**: Session-by-session data record for trained and untrained verb sentences. This figure shows the production of trained sentences as a result of the intervention. Responses after Step 2 are depicted in the graph as facilitation.

Changes in sentence structure: At the baseline, P7 produced sentences such as *the lady chopped the whatever it is* (*the woman chopped the pepper*). As well as the correct sentences, P7 produced incomplete sentences in the last session of the intervention such as *break the lady to the* (*the woman broke a stick*). These were not rescored as correct.

Clause elements at sentence level: For trained sentences, P7 produced elements such as subjects, verbs and direct objects at the baseline (Figure 8.8). As a result of the intervention, none of the changes in the production of verbs, direct objects and indirect objects were statistically significant. For the untrained verb sentences, none of the changes in the clause elements were statistically significant (Figure 8.9).

Production of verbs with affixes: The production of verbs with affixes was relatively high (4 out of 10) for P7. As a result of the intervention for sentences, P7 was able to produce more verbs with affixes than at the baseline (Figure 8.10). For P7,

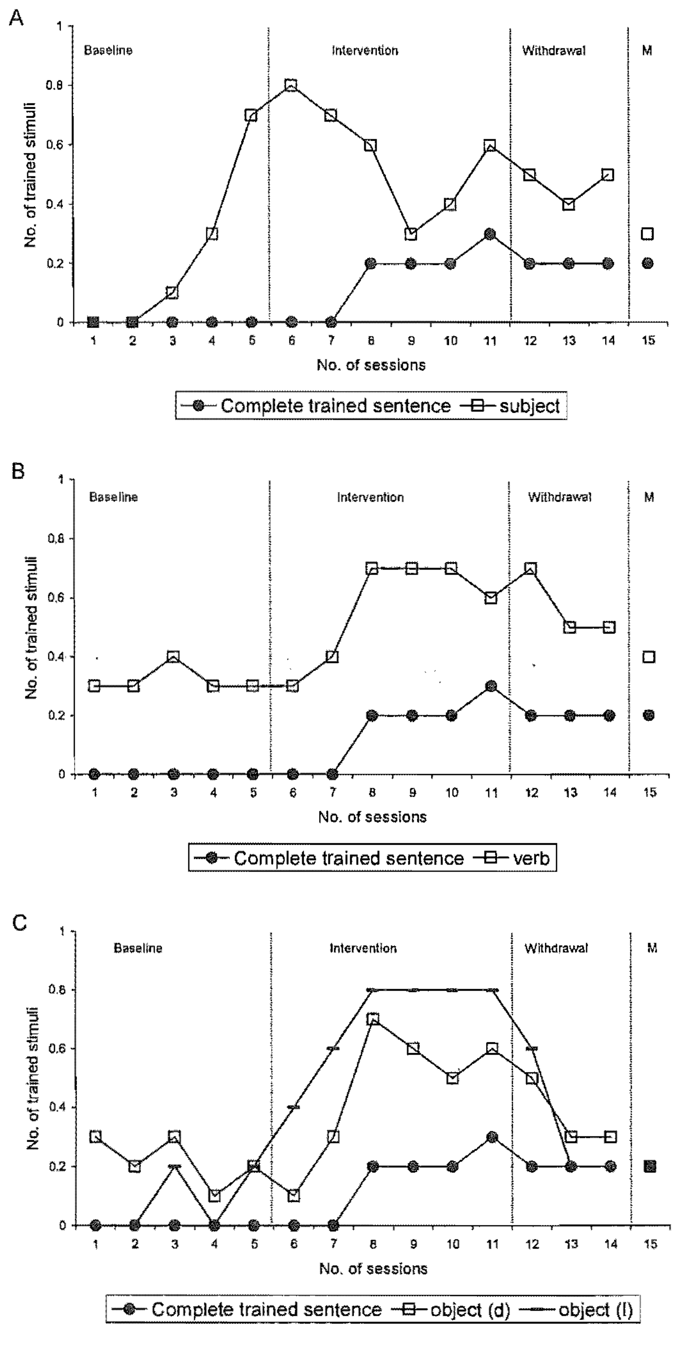

Figure 8.8. Comparison of the number of trained verb sentences and the clause elements produced in P7. Panel A shows the comparison between sentences and the subjects produced, Panel B shows the comparison between sentences and the verbs produced, and Panel C shows the comparison between sentences and the objects produced.

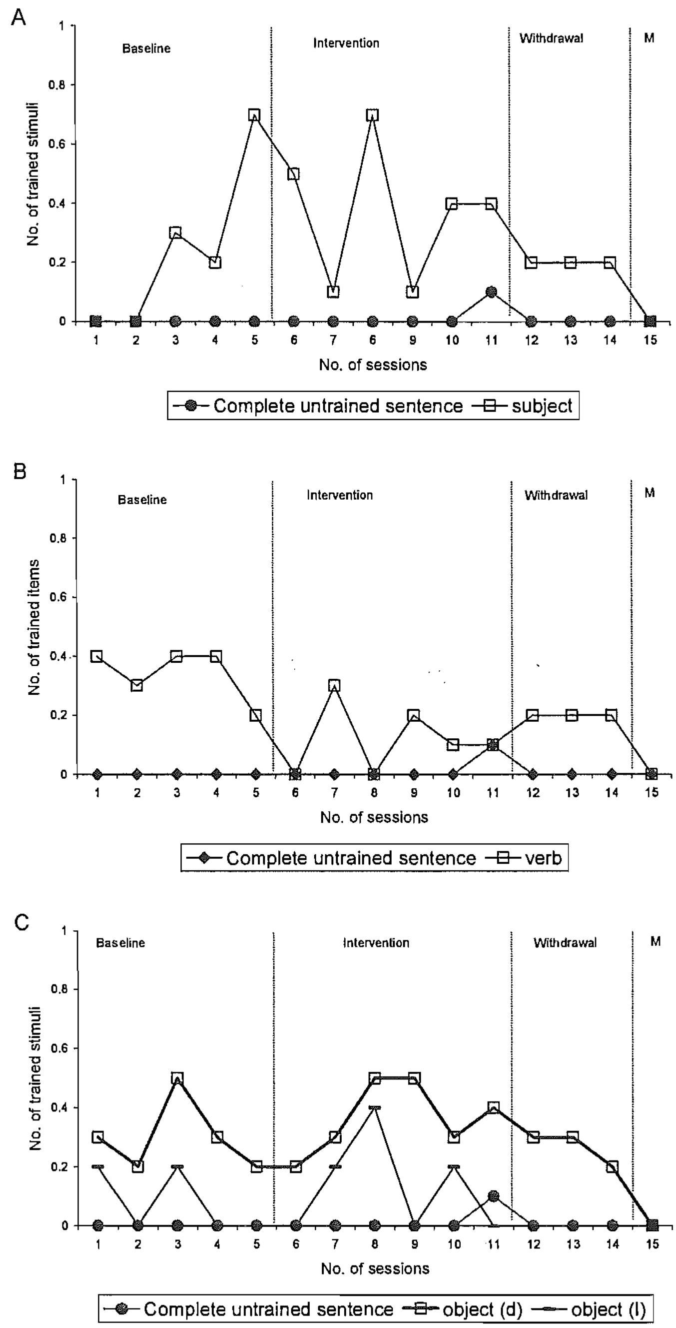

Figure 8.9. Comparison of the number of untrained verb sentences and the clause elements produced in P7. Panel A shows the comparison between sentences and the subjects produced, Panel B shows the comparison between sentences and the verbs produced, and Panel C shows the comparison between sentences and the objects produced.

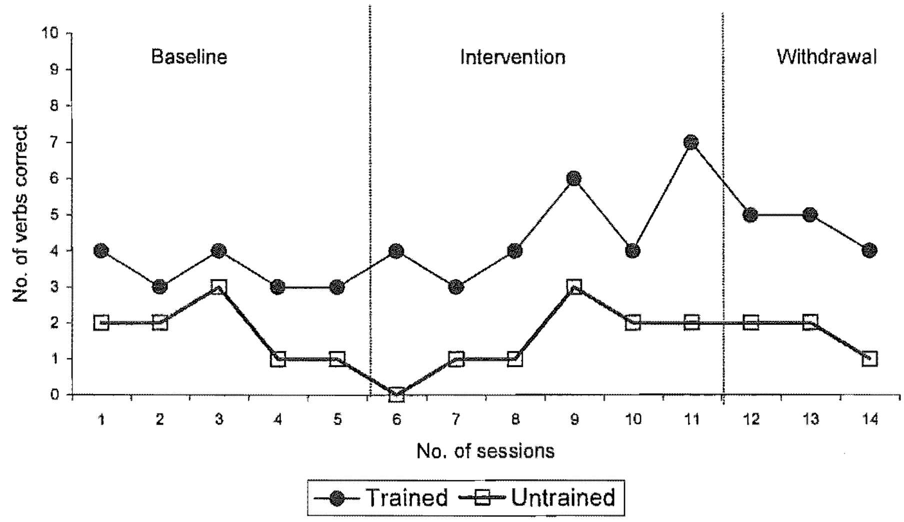

Figure 8.10. P7: Session-by-session data record for verbs with affixes.

production of verb-affixes changed from a score of four at baseline to a maximum of seven during verb argument module but declined with cessation of intervention for sentences. This change was not statistically significant.

Generalisation: No generalisation of the improvement seen on trained sentences was seen on sentences in the untrained category for P7 (Figure 8.9).

Summary: P7 showed a statistically significant increase in the production of sentences as a result of the intervention. There was no corresponding significant change in the production of clause elements.

8.7.4 Participant 8 (P8)

P8 was not able to produce any sentences during baseline testing as seen in Figure 8.11. As a result of the intervention, P8 showed an improvement in the production of sentences. His score increased from a zero to a maximum of five during intervention. The facilitation effect seen for sentence production was minimal. The increase in production of sentences was found to be statistically significant ($p<0.05$) using a celeration line and binomial test. The effect seen during the intervention did not remain at the same level during the withdrawal phase of the intervention. The production of verb sentences seen in P8 was maintained at a level of two (same as the withdrawal session).

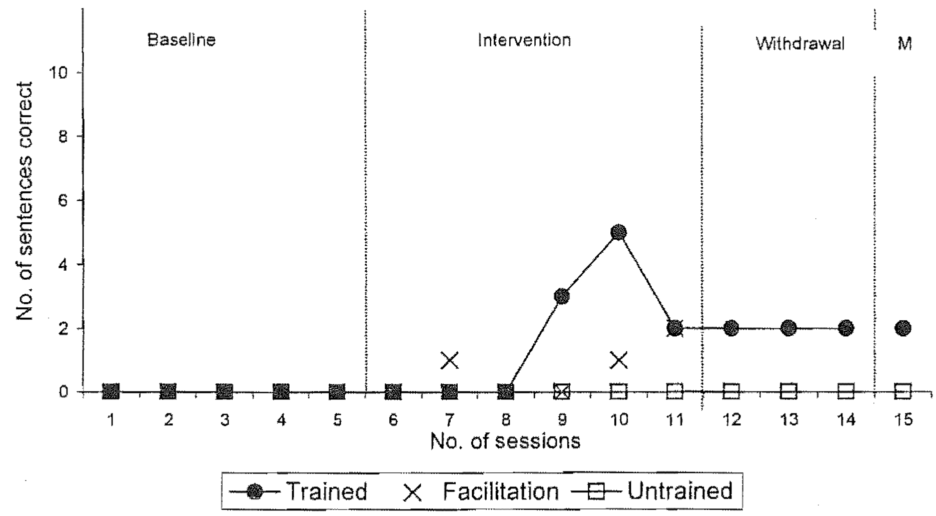

Figure 8.11. P8: Session-by-session data record for trained and untrained verb sentences. This figure shows the production of trained sentences as a result of the intervention. Responses after Step 2 of the intervention are depicted as facilitation.

Changes in sentence structure: P8 produced utterances rather than target sentences in the different phases of the intervention (e.g., *the lady with a lamp, the lady with a piece of meat*) identifying aspects of the picture and trying to describe what was happening in the picture (e.g., *the lady wiping the, the lady ...party to the boy*). After rescoring, there was no change in the original score. For untrained sentences, the utterances produced were similar such as *the lady and man with the waiter, the lady and the boy with the blocks.*

Clause elements produced at sentence level: P8 produced few subjects and minimal verbs at baseline. P8 showed a statistically significant increase in the production of subjects ($p = 0.016$, 1-tailed), direct objects ($p = 0.031$, 1-tailed) and indirect objects ($p = .063$, 1-tailed) for the trained set of verb sentences using McNemar's test (Figure 8.12). The increase in the number of subjects and direct objects produced was maintained at a lower level than seen during the intervention. Indirect objects were not maintained after the withdrawal of intervention.

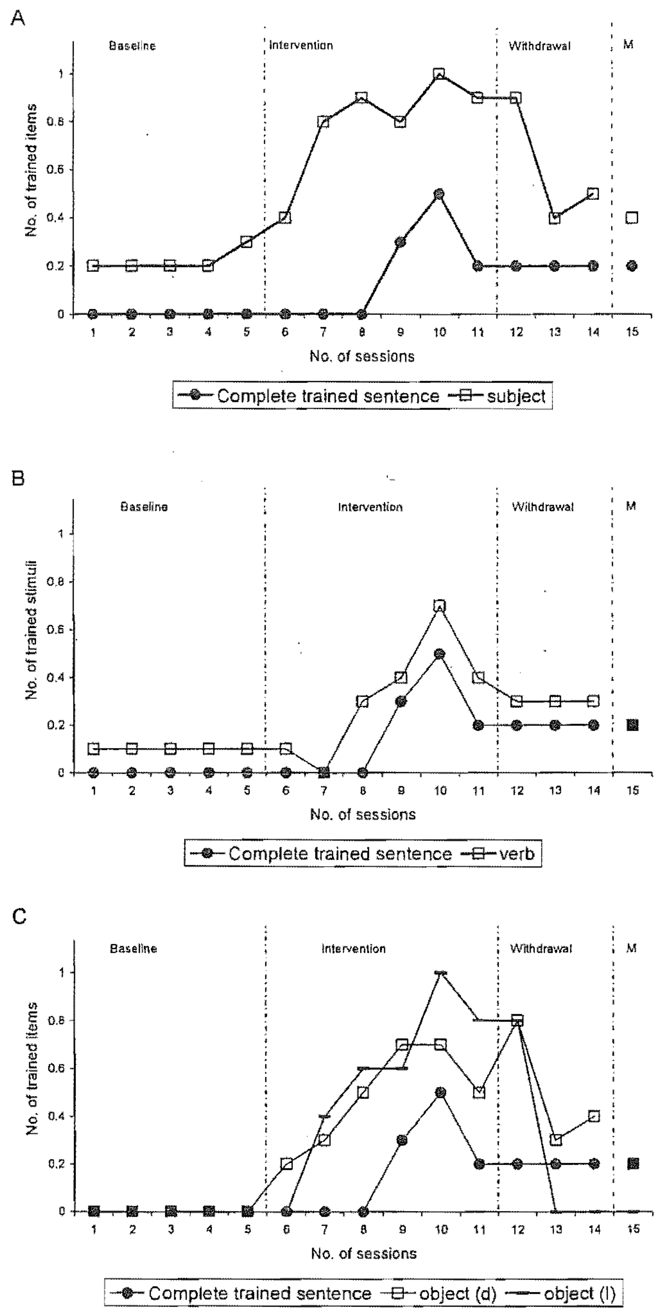

Figure 8.12. Comparison of the number of trained verb sentences and the clause elements produced in P8. Panel A shows the comparison between sentences and the subjects produced, Panel B shows the comparison between sentences and the verbs produced, and Panel C shows the comparison between sentences and the objects produced.

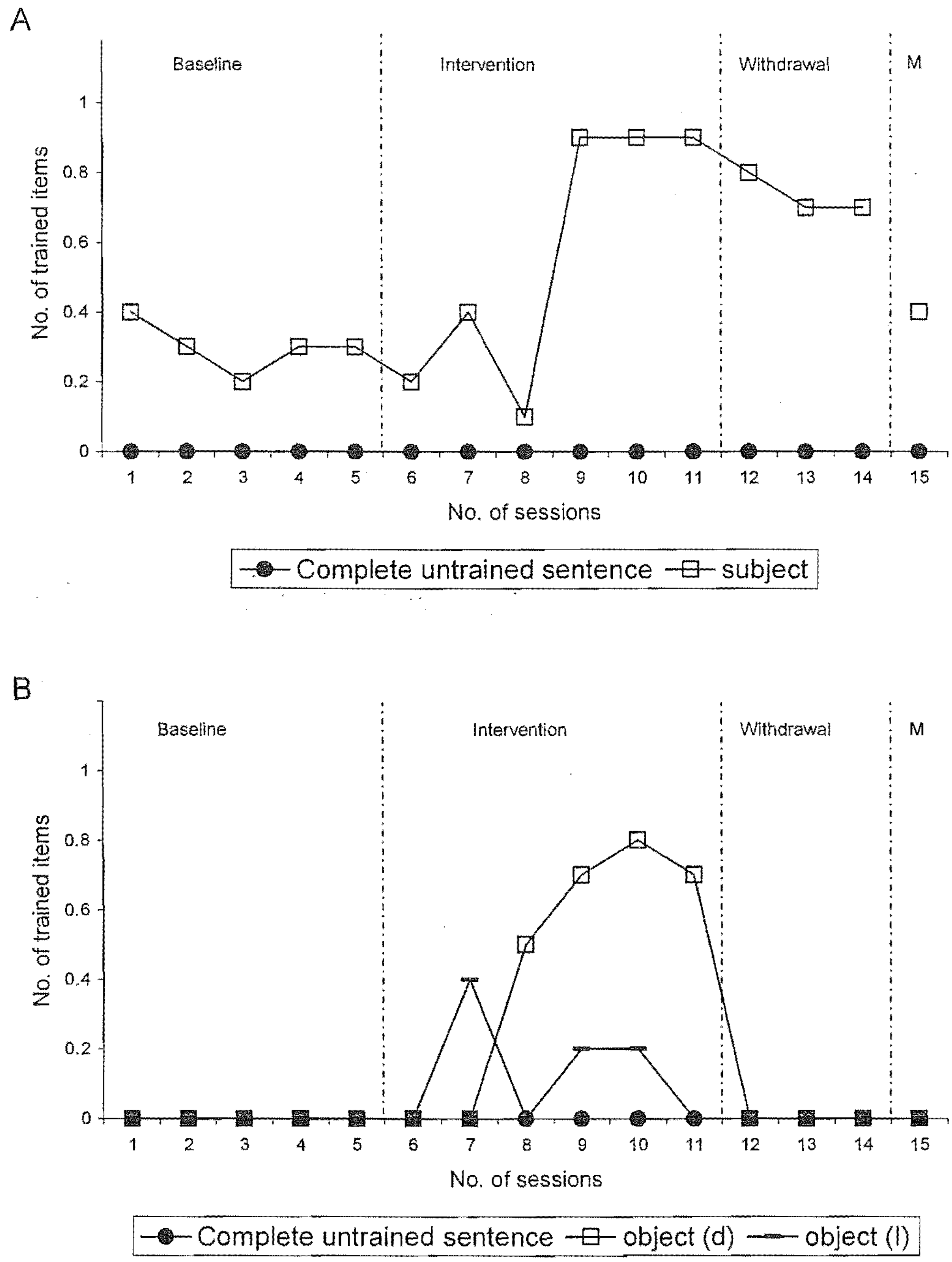

Figure 8.13 Comparison of the number of untrained verb sentences and the clause elements produced in P8. Panel A shows the comparison between sentences and the subjects produced, Panel B shows the comparison between sentences and the objects produced.

For the untrained set of verb sentences (Figure 8.13), only subjects were produced at the baseline. There was a statistically significant increase in the number of subjects (p = 0.031, 1-tailed) (Panel A) and the number of direct objects produced (p = 0.008, 1-tailed) (Panel B) during the intervention. However, the increase in the number of direct objects produced was not maintained after the withdrawal of intervention. No verbs were produced at the baseline or during the experimental intervention.

Production of verbs with affix: P8 was not able to produce verbs with affixes during baseline testing. P8 showed a non-significant change in the production of verbs with affixes: from zero to three verbs in the last intervention session (Figure 8.14).

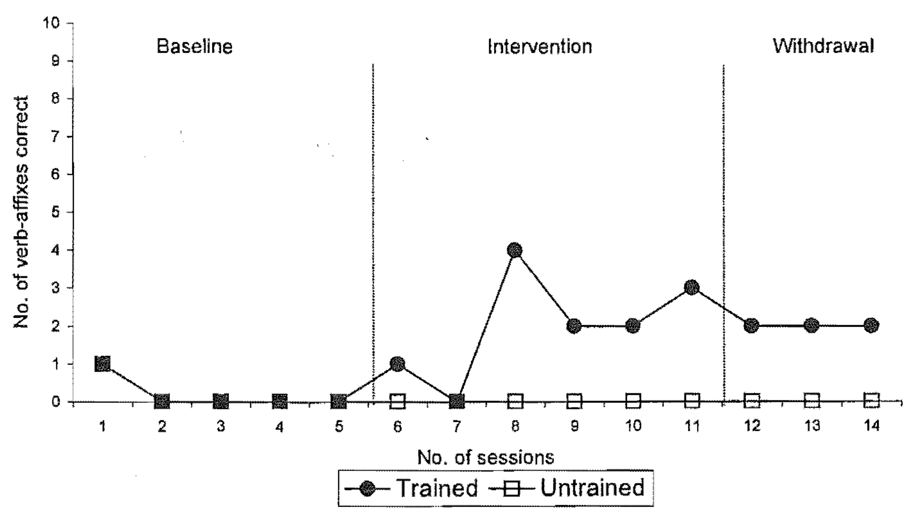

Figure 8.14. P8: Session-by-session data record for verbs with affixes.

Generalisation: No generalisation of the improvement seen for trained sentences was seen to complete target sentences in the untrained category for P8 (Figure 8.11). Generalisation was seen in terms of the production of subjects (p = .031, 1-tailed) and direct objects (p = .008, 1-tailed) for the untrained sentences (Figure 8.13). However, P8 did not show a significant change in the production of verbs with affixes at affix level as a result of the verb argument module (Figure 8.14).

Summary: P8 showed a statistically significant increase in the production of sentences as a result of the intervention. Analysis of sentences in terms of clause elements showed that there was a statistically significant increase in the production of subjects and direct objects.

8.8 Spontaneous speech

Table 8.5 presents some examples from the participants' speech samples. For P1 and P2, a comparison is made between their utterances in the last sample in Study 1, baseline (Study 1A) and after intervention (Study 1A). The changes in the samples are described in detail in terms of the LARSP variables that were tested for reliability and were found to be reliable (see chapter 5, section 5.8.7.4). The reliable variables were total utterances, clausal complexity, number of nouns and number of verbs.

The scores obtained for all the variables examined in the two samples for the four participants are presented in Tables F.7 and F.8 (see Appendix F) along with the mean values and the range of spontaneous speech measures for normal speakers. Table 8.6 presents the values for the reliable LARSP variables measured for the four participants. A comparison was made between the values obtained at the baseline and after the intervention. A statistical analysis could not be done because of the use of single subject design that made only one sample available at each point in time for each participant.

P1: After the intervention, there was a change in the total utterances produced. Lexically, there was an increase in the number of noun tokens but a minimal change in the verb tokens.

P2: For P2, there was a minimal change in the total utterances produced. The overall change could be attributed to variable performance. A large part of her utterances at the baseline and after the intervention were stereotypes.

P7: For P7, there was a change in the total utterances produced and in the clausal complexity of the utterances produced. In comparison to normal speakers, P7 had a reasonable number of utterances (36 in comparison to the highest range of 54 in normal

Table 8.5 Excerpts from the spontaneous speech samples for the four participants. Utterances are separated by commas. The words in the brackets represent mazes. All the participants are responding to the same picture (rescuing the cat).

P1

Sample 4 (Study 1): Ladder, man's ladder, cookie, a fire engine.

Baseline (Study 1A): Girl on the tree cat, he did a hole, ran, no.

After intervention (Study 1A): A man up tree, ladder, with ladder, a tree, ladder, dog barking up.

P2

Sample 4 (Study 1): Yes, cat and, but here beside, here (uh), ladder and, but here beside, here beside boo, (man) yes, man, here beside, a ladder (wooo), ladder, lad and a fire engine, yes, a fireeng(ine), a fireengine and huh, and here beside and here beside.

Baseline (Study 1A): Dad shoes and socks, but here beside and here beside, girl and dress and yes, bike and or yes, here beside, fire engines, and here beside.

After intervention (Study 1A): Girl and sleep, here beside, sleep, bird, here beside, fire engine, but here beside, fire engine.

P7

Baseline: Cat is stuck up the tree, stuck on the tree, barking the cat, the dog is barking to the boy who is stuck on the stalk, I know this one is using the ladder with the lock, the ladder for the.

After intervention: This man at the top of the, trying to get the pussy cat off the I can't say that, and the dog is jumping trying to, the poor dog and the cat between the two, and the little girl is trying to get the cat around, the man is trying to go up the no.

P8

Baseline: That is a little girl on a trike, and that is a man on the tree with a dog going up the back, and the little girl with a trike, and two men trying to get him up the… to take him off, off there on to the bottom, and the truck waiting to get him up to.

After intervention: The girl was fat [cat] on the tree, she was trying to take it and come it home, and the dog, and the man on the ship he was trying to, with the dog and the two men there taking off on the tree.

Table 8.6 Mean and range values of spontaneous speech measures for normal speakers and from samples of P1, P2, P7 and P8 obtained during baseline (B) and after verb argument module1 (I).

Measures	Mean	Range	P1-B	P1-I	P2-B	P2-I	P7-B	P7-I	P8-B	P8-I
Utterances										
Total utterances	31.78	19-54	16	26	40	42	28	36	43	43
Clausal complexity	9.91	7.33-15.83	2.63	2.69	1.38	1.24	7.6	8.69	8.67	4.89
Lexical										
Nouns – Types	47.07	31-75	11	10	25	19	27	31	23	25
Nouns – Tokens	66.85	38-126	11	21	39	26	50	51	58	59
Verbs – Types	35.85	23-62	5	6	4	3	22	40	16	12
Verbs – Tokens	51.21	28-90	5	8	4	3	31	57	45	20
Verb valency										
Intransitive types	17.28	6-36	3	4	4	2	12	23	5	5
Intransitive tokens	23.92	8-48	3	5	4	2	16	28	11	9
Transitive verbs – Types	19.00	12-28	2	2	0	1	10	15	10	6
Transitive – Tokens	26.28	15-52	2	3	0	1	15	24	31	10
Ditransitive types	0.429	0-2	0	0	0	0	0	1	1	1
Ditransitive tokens	0.857	0-4	0	0	0	0	0	3	3	1

speakers). There was an increase in the types of nouns and verbs produced. The number of verbs produced after the intervention was in the mid-range of normal speakers. There was an increase in intransitive and transitive types of verb types produced. The number of verb tokens produced in each category also changed. There was a minimal change in the number of ditransitives produced.

P8: For P8, none of the variables showed a change in the positive direction in comparison to the baseline. P8 has the sentence structure but is not able to retrieve some of the nouns and verbs during spontaneous speech. A lower production of the number of utterances and the nouns and verbs produced indicate a variable performance.

8.9 Pre-and post-intervention battery

The pre-intervention battery was re-administered after the intervention to see if there were any overall changes in the language ability of the participants. Table 8.7 compares the response of the four participants to the various tests in the pre-intervention and the post-intervention battery. McNemar's test was used to test statistical significance.

P1: In the Verb Production Battery, the change in production of subjects was found to be statistically significant ($p = 0.031$, 1-tailed). None of the changes in the sentence comprehension test were found to be significant. In PALPA, changes in noun comprehension were not found to be statistically significant (subtest 47).

P2: For P2, changes in naming ($p=0.002$, 1-tailed) on the BDAE were found to be statistically significant. The changes in noun comprehension and other tests (i.e., Verb Production Battery and sentence comprehension) were not found to be statistically significant.

P7: For P7, none of the changes in the positive or negative direction on any of the tests were statistically significant.

P8: In the Verb Production Battery, an increase in the number of verbs produced in isolation ($p = .002$, 1-tailed) and in the number of verbs produced during sentence production ($p = 0.004$, 1-tailed) was found to be statistically significant. The remarkable change in the number of subjects was found to be statistically significant ($p < 0.05$, 1-tailed). The increase seen in the production of nouns (PALPA subtest 53) was found to be statistically significant ($p = .031$, 1-tailed).

Table 8.7 A comparison of the language ability of the four participants during pre-intervention and post-intervention. An asterisk shows that the change is statistically significant using McNemar's test. Degrees of freedom are equal to one. Scores of BDAE are raw scores. Aud comp (auditory comprehension), verb prod (verb production), verb comp (verb comprehension), direct obj (direct object), SR (subject relative), OR (object relative)

	P1 (pre)	**P1 (post)**	**P2 (pre)**	**P2 (post)**	**P7 (pre)**	**P7 (post)**	**P8 (pre)**	**P8 (post)**
BDAE								
Fluency (21)	11	9	10	11	15	19	19	19
Conversational speech	6	7	6	6	7	7	7	7
Aud comp	27	29	25	23	29	26	29	28
Repetition (7)	5	5	4	3	20	24	21	25
Naming (37)	34	34	5	14*	4	4	3	4
Verb production battery								
Verb prod (27)	17	13	7	5	23	21	4	13*
Verb comp (27)	26	27	25	24	27	27	27	27
Subject (33)	6	11*	24	20	7	8	15	33*
Direct obj (23)	7	9	7	2	16	11	6	6
Indirect object (8)	2	0	2	0	1	3	0	0
Verbs (33)	27	26	19	20	33	33	23	31*
Sentence comp								
A (Active, 20)	10	12	13	12	12	10	10	10
P (passive, 20)	13	9	5	5	12	11	12	11
SR (20)	15	15	7	7	14	10	10	10
OR (20)	10	15	11	10	11	11	10	10
PALPA								
Subtest 47 (40)	33	37	34	36	40	40	39	38
Subtest 53 (40)	37	38	12	13	19	21	21	26*

8.10 Verbs with affixes and sentence production

The results of the intervention raised a question: is there a relation between the verbs with affixes produced during testing and the sentences that were successfully produced during facilitation and during the treatment probes at the end of the intervention sessions. The verbs with affixes produced during the entire intervention phase of Study 1A were counted. A comparison between the verbs with affixes produced with ongoing intervention and the sentences and utterances produced after the intervention would show if the availability of a verb was a definite indicator of the successful production of a sentence using that particular verb.

Table 8.8. Verbs with affixes produced during Study 1A. *Verbs with affixes* represent the verbs produced during testing. *Sentence facilitation* represents the production of sentences after facilitation (presentation of verb plus arguments to the participants), *sentence intervention* represents the production of sentences during the probe after intervention and *verbs instead of sentences* represents the production of verbs instead of the sentence during the probe. Each verb was assigned a number. The numbers represent the specific verb that was produced.

Participants	Verbs with affixes	Sentence Facilitation	Sentence intervention	Verbs instead of sentences
P1	2,5,8	1,3,4,8,9,10	1,2,5,10	3,7,8
P2	2,4,6	zero	zero	2,6,7
P7	1,2,3,4,6,7,8	3,4,5,10	6,7,9,10	1,2,4
P8	2,3,5,6,7,8	1,6,7,9	2,4,5,6,7	8

Table 8.8 shows that facilitation helped P1 in the production of five new sentences but did not help P2. New sentences were defined as sentences for which verbs with affixes were not produced during the intervention. P7 and P8 both produced two new sentences after facilitation. After the intervention, P1 and P2 did not produce new sentences. P7 and P8 both produced one new sentence after intervention. Thus the verbs with affixes that were produced were more likely to be produced as sentences but the

availability of the verb was not a definite indicator of successful sentence production using that particular verb.

8.11 Final summary

Three of the four participants showed a statistically significant change ($p<.05$) in the number of sentences produced after the verb argument module (see Table 8. 9). A change in spontaneous speech in terms of the number of verbs produced was seen only in P7.

Table 8.9 Summary of the changes seen in the four participants. An asterisk indicates changes that are statistically significant at $p<.05$ level.

	P1	**P2**	**P7**	**P8**
Verb argument module	*Statistically significant	No change	*Statistically significant	*Statistically significant
Facilitation (Step 2)	Change	No change	Change	No change
Clause elements (trained sentences)	*Direct objects	*Subjects	No change	*Subjects, direct objects and indirect objects
Spontaneous speech	Minimal change in verb tokens	No change	Increase in the intransitive and transitive types of verbs	Variable performance

8.12 Discussion: Results and hypotheses

The results obtained will be discussed in terms of the hypotheses of Study 1A (see section 8.5).

8.12.1.1 Hypothesis 1: benefits for trained sentences

The experimental intervention in Study 1A resulted in a statistically significant increase in the number of trained sentences produced in three of the four participants (P1, P7 and P8). Therefore, hypothesis 1 is partially supported.

8.12.1.2 Hypothesis 2: benefits for untrained items

The experimental intervention in Study 1A did not result in an increase in the production of untrained sentences that were linguistically similar to the trained sentences. Therefore, hypothesis 2 was not supported. In terms of clause elements, P8 showed a statistically significant increase in the production of subjects and direct objects for untrained sentences.

8.12.1.3 Hypothesis 3: benefits for spontaneous speech

The experimental intervention resulted in an improvement in spontaneous speech in terms of an increase in the types of verbs produced in one participant (i.e., P7) only. Therefore, hypothesis 3 was partially supported.

8.12.2 Results in relation to the clinical aphasiology literature

Studies closely associated with verb arguments are mapping therapy studies that teach a patient to associate the grammatical roles with functional roles or in very broad terms the mapping between syntax and semantics (Byng et al., 1994; Schwartz et al., 1994). We are not aware of studies that present the verb and the verb arguments without elaborating on the grammatical and functional roles. In Study 1A, though only the verb and the arguments were presented, the argument structure may be implicit because there was only one order of presentation i.e., action followed by agent and theme.

Mapping therapy studies have shown a remarkable improvement in the trained items. The therapy task in such studies involved making the thematic roles explicit by specifying the action, the doer of the action and the theme of the action. Roles have been made explicit by using color codes, cue cards, and illustrations specifying the relationship between the different parts of a sentence. Only two studies that focused on mapping (Jones, 1986; Byng, 1988) found generalisation to untreated verb classes. The specification of roles is in contrast to the therapy task used in the present study where only the verb arguments were presented. Therefore, results of Study 1A indicate that specification of thematic roles may play an important role in therapy for sentence production.

8.13 Questions raised by the results of Study 1A

The results raise the following questions:

1) Why was there a variation in the performance of the participants in terms of the effect of intervention on trained sentences?
2) Why was there a better response to facilitation (where the verb and its arguments were presented) than to the presentation of the arguments plus the sentence in the verb argument module?
3) Why did P2 not show a change in the production of sentences as a result of the intervention?
4) Why was no generalisation from trained to untrained sentences seen?
5) Why was an increase in spontaneous speech variables seen in two of the four participants only?

The questions are discussed in the order of presentation.

8.13.1 Variation in performance

The variation in performance may be due to a difference in the locus of the participants' impairment as proposed by GEM, a difference in their performance on the Verb Production Battery and PALPA, and a difference in the language characteristics as identified by the BDAE. Study 1 showed that participants with the same symptoms might have more than one impaired level within GEM.

8.13.1.1 Hypothetical locus of impairment

During pre-intervention testing, detailed testing for verbs and nouns was performed that provides cues to the probable locus of impairment. No detailed analysis of identification of thematic roles was done to rule out mapping deficits because the focus of the present study was only on the production of active and canonical sentences. Based on the pre-intervention battery testing (see Table 8.10), a hypothetical locus of impairment can be speculated for each participant.

Table 8.10 Abilities of the four participants in terms of comprehension and production of verbs and nouns and in spontaneous speech. S (subject), Od (direct object), Oi (indirect object), V (verb).

Ability	P1	P2	P7	P8
Verb production battery				
Verb comprehension	96%	92.5%	100%	100%
Verb production (isolation)	63%	26%	85%	15%
Sentence production	Production of S, Od and Oi affected	Od, Oi and V sparsely produced	Production of S and Oi poor	Production of Od and Oi affected
PALPA				
Noun comprehension	82.5%	85%	100%	97.5%
Noun production	92.5%	30%	47.5%	52.5%
Spontaneous speech	Contained sentences with incomplete arguments	Consisted largely of nouns with conjunction *and.*	Incomplete sentences due to poor noun retrieval	Incomplete sentences with grammatical morphemes

P1: P1 produced function words but the content was poor. Her noun retrieval was better than verb retrieval in isolation. Verb production during sentences was better than in isolation.

P2: Both noun and verb retrieval was poor. Verb production during sentences was better than in isolation. Her features are similar to P1 but her extent of problem in verb retrieval and noun retrieval is greater than for P1.

P7: P7 had a good ability to produce grammatical morphemes. Verb production during sentences was better than in isolation. Her poorer noun retrieval in comparison to verb retrieval indicates a lexeme retrieval problem specifically for nouns.

P8: Verb production in sentences was better than in isolation. In isolation, noun retrieval was relatively better than verb retrieval though both were impaired.

These four participants are similar to a certain extent in their abilities with good comprehension but poor production of verbs and nouns in isolation, and affected sentence production with incomplete sentence structure as a result of either noun retrieval problems or verb retrieval problems. The severity of verb retrieval and noun retrieval problems varies among these participants. None of these participants were able to produce all the verbs in isolation in the same test battery or produce all the nouns in the PALPA subtest. In noun comprehension, majority of the errors were close semantic distractors in P1, P2 and P8 (see Table 8.11). In noun production, errors included semantic and phonemic errors and no responses. The participants were probably not able to retrieve the lexemes of those particular verbs that they were unable to produce. We can hypothesise that three of the four participants have a problem with lexeme retrieval at the positional level though the severity of the impairment varies. P1 had impaired lexeme retrieval while P2 had impaired lexeme retrieval and an additional impaired process, likely to be impaired planning frame because her sentences lacked a structure. An additional lexical semantic impairment in P1 and P2 cannot be ruled out from the tests administered.

The hypothetical impairment of lexeme retrieval in P1 and P7 is supported by their improved production of sentences as a result of facilitation. P8 did not improve as a result of facilitation despite impaired lexeme retrieval most likely because providing the verb arguments was not sufficient to help him to retrieve the relevant lexemes.

8.13.2 Lack of change in P2

P2 did not show any improvement in the production of sentences after either facilitation or the verb argument module. This lack of effect could be explained by overall poor abilities on the Verb Production Battery and on the PALPA subtests. P2

Table 8.11 Types of errors on PALPA subtests and their percentage. CSD (Close semantic distractor), DSD (Distant semantic distractor), VRD (visually related distractor), UD (unrelated distractor), NR (no response and responses such as cannot say, do not know)

Participant	Comprehension	Production
P1	CSD (71.4%)	Semantic (33.3%)
	VRD (14.28%)	NR (66.6%)
	UD (14.28%)	No. of errors (3)
	No. of errors (7)	
P2	CSD (66%)	Semantic (42.8%)
	DSD (16.6%)	NR (57.1%)
	VRD (16.6%)	No. of errors (28)
	No. of errors (6)	
P7	No errors	Semantic (14.2%)
		Phonemic (9.5%)
		Unrelated (4.76%)
		NR (71.4%)
		No. of errors (21)
P8	CSD (100%)	Semantic (21.05%)
	No. of errors (1)	Phonemic (26.3%)
		NR (52.6%)
		No. of errors (19)

ranks the last among the four participants in her ability to comprehend verbs, to produce verbs during sentence production with a written cue and to produce nouns. She ranks the second last in verb retrieval and in noun comprehension. Her overall poorer ability in both comprehension and production of both verbs and nouns may be a possible explanation for a lack of improvement. Her poor ability on verb comprehension and verb production in comparison to the other participants indicates impairment both at the lemma retrieval level and the lexeme retrieval level.

It was noted that P8 also shows a poor response to facilitation in comparison to the responses of P1 and P7. A poor response to facilitation can be linked to poor verb production in P2 and P8 as compared to P1 and P7 because these two participants are similar in their performance on production of verbs in isolation and during sentence production of the Verb Production Battery.

8.13.3 Lack of generalisation from trained to untrained sentences

In Study 1A, there was a lack of generalisation from trained to untrained sentences despite their linguistic similarity. P8 was the only one to show a statistically significant change in the production of subjects and direct objects for untrained sentences. A possible explanation could be that, although the participants in the verb argument module were presented with the verb and the arguments and asked to produce the target sentence twice, the information about the verb, the arguments and the grammatical and functional roles was not made explicit. There was no semantic component (e.g., specification of roles as in mapping therapy) in the task in Study 1A when the verb arguments were presented along with the target sentence. A lack of generalisation in this study strongly indicates that the clarification and specification of thematic roles is an important one (e.g., Jones, 1986; Byng, 1988).

Even participants with relatively good verb retrieval (i.e., P1 and P7) did not show generalisation to untrained sentences. The lack of generalisation implies that other factors besides verb retrieval and besides argument retrieval are affecting sentence production (e.g., Mitchum & Berndt, 1994). Additionally, the therapy task may not have been able to activate the impaired process of lexeme retrieval thus limiting the effect of intervention to the trained items (e.g., Hillis, 2001).

8.13.4 Effect of intervention on spontaneous speech measures

The verb argument module resulted in a change in the positive direction on spontaneous speech in two (i.e., P1 and P7) of the four participants in terms of an increase in the total number of utterances produced. There was also an increase in the number of tokens of nouns (for P1) and verbs (for P7) produced (see Table 8.6). A statistical analysis was not done on the spontaneous speech measures.

For P1, the post-intervention battery measures indicated a statistically significant change in the production of subjects in the Verb Production Battery. In addition, P1 showed a statistically significant change in the production of direct objects. This correlates with her improvement in the production of noun tokens in spontaneous speech. For P7, none of the changes in the post intervention measures were statistically significant but the generalisation from verb argument module to spontaneous speech could be attributed to her better overall performance on the Verb Production Battery and on PALPA during the pre-intervention battery. Results for P1 indicate a link between nouns and increased output while results for P7 point to a link between verbs and increased speech output.

In contrast, P2 and P8 showed a change in the negative direction on a majority of the spontaneous speech measures. P2 did not show any changes in the production of sentences during the intervention. Additionally, P2 had poor performance (pre-intervention) on verb production in the Verb Production Battery and her production of verbs in spontaneous speech was low. Post intervention measures show that even though P2 did not improve in her production of sentences, she improved significantly in naming on BDAE. Her improvement in naming is consistent with a statistically significant increase in the number of subjects produced during the intervention.

Poor performance on verb production can explain the results for P2 but poor performance on verb production cannot explain P8's poor performance on the spontaneous speech measures. P8 showed a poor response to spontaneous speech despite P8 showing the best performance during the intervention. The reason for a low production of verbs after the intervention is not clear. Surprisingly, the post intervention measures indicate a statistically significant change in the production of verbs during sentence production in the Verb Production Battery. There was a corresponding increase in the production of verbs in isolation that was found to be statistically significant. In addition, P8 showed a statistically significant change in the production of subjects, direct and indirect objects for trained sentences; and subjects and direct objects for untrained sentences. A poor performance on spontaneous speech despite significant changes in the Verb production battery suggests that spontaneous speech measures may not be sensitive to the changes in P8.

8.14 Relationship between verb retrieval and sentence production

Verb retrieval is an important aspect of sentence production but may not be the only crucial aspect of sentence production. Analysis of sentences in terms of clause elements produced revealed that none of the participants showed a statistically significant change in the production of verbs. However, the verb argument module resulted in significant changes in the production of other clause elements in P1 (direct objects), P2 (subjects) and P8 (subjects, direct objects and indirect objects). The change in clause elements could be attributed to the activation of the verb lemma due to the presentation of the verb and the verb arguments during the intervention. However, no increase in the production of verbs indicates that the presentation of verb arguments along with the verb might have resulted in an increase in the clause elements.

8.15 Relation between verbs with affixes and sentence production

In Study 1, we speculated that an increase in the production of verbs with affixes could correlate with an increase in the production of sentences because the affix could help in the retrieval of the planning frame (see section 5.6.1.4). However, no generalisation from the affix module to sentence production was seen. The same relationship was further explored in Study 1A by comparing the production of verbs with affixes and sentences. The relationship between production of verbs with affixes and sentence production is not clear. For P1, there was no change in the production of verbs with affixes even though there was an improvement in the production of sentences. For P2, there was a change in the production of verbs with affixes but there was no increase in the production of sentences. P7 and P8 show a change in the production of verbs with affixes and an increase in the production of sentences. A detailed correlation of verbs with affixes produced in different phases in Study 1A shows that verbs that were produced with affixes were more likely to be produced as sentences but the availability of the verb was not a definite indicator of successful sentence production (see section 8.10).

8.16 Comparison of the effect of the word module and the verb argument module

A direct comparison between the word module in Study 1 and the verb argument module in Study 1A cannot be made because of a difference in the verbs trained. The participants P1 and P2 in Study 1 and Study 1A were the same. In Study 1, the effect of the word module was limited to the production of verbs in isolation and sentences with incomplete argument structures. In Study 1A, the effect of the verb argument module did help in the production of sentences with complete argument structures (only for P1) though the improvement was not maintained. A difference in the response to the intervention in Study 1 and Study 1A implies further research that compares the effect of verb arguments and verbs in isolation on sentence production.

8.17 Implications for the GEM of sentence production

Study 1A provides evidence that information about a verb and its arguments is essential for sentence production and results in improved sentence production in three of the four participants. The possible explanation for an improvement in sentence production seems to be that providing a verb along with the verb arguments facilitated lexeme retrieval in these participants. Facilitation of lexeme retrieval correlated with the hypothetical locus of impairment in these participants i.e., impaired lexeme retrieval. Thus Study 1A supports the importance of lexeme retrieval for sentence production and implies that though the lemma activated the verb arguments, patients with aphasia were not able to produce the arguments because of impaired lexeme retrieval at the positional level. In contrast, P2, who had impairment at more than one level, did not improve. Study 1A supports Study 1 and strongly implies that models of sentence production such as GEM are applicable to patients with impairment limited to one particular process at a specific level.

Study 1A shows that information about verbs and verb arguments is crucial for production of sentences but may not be sufficient for producing a sentence. Results for facilitation (where the verb and its noun arguments were presented) support the results of Study 1 by implying that either the information about verbs and verb arguments is inaccessible for patients with aphasia or they are unable to retrieve the lexemes. In addition, an important point to note is that the effect of facilitation is not seen in all the four participants in this study. This lack of similarity in the performance patterns of the participants indicates that additional impaired processes besides access to argument structure are the cause for impaired sentence production.

8.18 Clinical implications

Study 1A indicated that using the verb argument module might not result in a maximum improvement in production of sentences. Of more importance may be the specification of the functional and the grammatical roles as in mapping therapy. In addition, Study 1A indicates that performance on verb retrieval, comprehension and fluency may be crucial for successful outcome of the participants. It is of both clinical and theoretical importance to know more about the subject factors that predict good and poor outcomes (Schwartz et al., 1994, p. 23). The ideal candidate for this type of intervention (as in Study 1) seems to be participants like P7 and P1 with average retrieval skills for verbs and nouns and who have an ability to use cues such as picture cues.

8.19 Conclusion

Study 1A implies that when the arguments are provided to the participants, they may benefit from the presentation if a lack of access to the arguments is the reason for their impaired sentence production. Information about verbs and verb arguments is important for sentence production but mere presentation of the information (e.g., without explanation of roles) may not be enough to result in a permanent improvement in sentence production.

Because the verb argument module helped three of the four participants (i.e., P1, P7 and P8) to produce sentences, the data in Study 1A suggest that patients with aphasia are not able to access the verb arguments. There are two possible reasons for the patients not being able to access the verb arguments. First, the verb lemma did not activate the verb arguments. Second, the verb lemma activated the arguments but the impaired lexeme retrieval did not retrieve the lexemes. Further research is needed to evaluate the symptoms that would differentiate between inactivation of the verb lemma and the ability to access the verb arguments.

9 Chapter Nine: Discussion and Conclusion

9.1 Introduction

A cognitive neuropsychological (CNP) approach to intervention was used to test the validity of a model of sentence production based on normal speakers by using language-impaired individuals (patients with aphasia) as participants. The experimental intervention was designed to improve production of sentences in patients with aphasia. A grammatical encoding model (GEM) of sentence production was used to define the experimental intervention at three different levels of the model. The generalisation patterns of the model-based intervention were predicted based on GEM and on the clinical aphasiology literature. The validity of GEM was evaluated by analyzing the performance patterns of the participants to find if the results conformed to the predictions of GEM.

Two studies were carried out. The studies examined the relationship between verb retrieval and sentence production and examined aspects of the information activated by a verb lemma. Study 1A was a follow up study to Study 1.

9.2 Achievement

Experimental intervention: GEM was used to design the experimental intervention, which was at three different levels of the model (see Chapter 5). Responses of the participants to the intervention were evaluated in Study 1. Two of the six participants (P1 and P2) showed a statistically significant change in the production of trained items (see Chapter 6). P1 showed a significant change in the production of trained verbs, verb affixes and verb sentences. P2 showed a significant change in the production of trained nouns, noun affixes and noun sentences.

The question raised by the lack of generalisation from verbs in isolation to production of sentences in Study 1 was: Does the lemma of a verb activate the argument structure of that particular verb in patients with aphasia (as in normal speakers)? If the verb lemma is unable to provide the argument structure, then providing the arguments should help. This question was asked in Study 1A.

Study 1A demonstrated that presentation of verb arguments resulted in an improvement in the production of sentences for some of the trained verb sentences in three of the four participants. The change in the production of sentences as a result of the intervention provides evidence that verbs and verb arguments are important for sentence production but they are not sufficient for sentence production. This evidence implies that there is a need for exploring other factors that act as hurdles for accurate sentence production in patients with aphasia.

Relationship between verb retrieval and sentence production: Study 1 provides evidence that, although one participant showed a statistically significant change in the production of trained verbs, there was no generalisation from training at word level to production of sentences. After the word module for verbs, P1 was able to produce subjects with the verb and direct objects with the particular verb. Though P1 had generally good noun retrieval, she may have problems with lexeme retrieval of the particular verb argument in question. The evidence of a lack of generalisation implies that a verb lemma may not activate arguments in a production task in patients with aphasia or that the patients may not be able to access the lexemes.

Generalisation to untrained stimuli: According to Hillis (2001), if treatment influences a general processing mechanism, processing should improve across all stimuli that are subject to that mechanism (p. 517). No generalisation from trained to untrained stimuli in the studies in this thesis implies that a general processing mechanism did not improve because of the experimental intervention. In other words, the intervention task did not influence the impaired process (i.e., verb lemma activation and/or impaired lexeme retrieval) in the participants as anticipated.

In Study 1A, despite the expectation that the intervention task was targeting a process and should result in generalisation to linguistically similar items, no generalisation was seen in terms of production of complete sentences. P8 was the only one who showed a statistically significant increase in the production of subjects and the number of direct objects produced for untrained sentences. Thus, generalisation was seen in one participant in terms of clause elements.

One of the explanations proposed by Schneider and Thompson (2003) to explain generalisation within or across verb categories was that complex structures were trained in their participants (three-place change of state verbs such as *the girl is filling the pitcher with water*). This explanation of training complex structures does not hold for the present study because three-place action verbs were used but no generalisation was seen.

Generalisation to spontaneous speech: There was generalisation from improvement in the trained items (in P1 and P2) to a significant change in the number of nouns and verbs produced (in P1 and P2). The changes seen in P5 were considered to be due to variable performance.

9.3 The present thesis and the literature

CNP models are based on normal speakers and propose the processes required to perform a particular cognitive task in the normal population. In a CNP approach, such models are applied to brain damaged patients. Although cognitive models are not models of learning and cannot explain why one patient can learn using a strategy to remediate a particular process but the other one cannot learn (e.g., Hillis and Caramazza,1994), cognitive models can help in focusing therapy and providing directions for what should be the therapy target. The studies in the present thesis support this point of view because GEM outlined the modules and the areas of focus of the intervention.

The results of Study 1 are consistent with the following proposals from the literature:

a) Verbs play an important role in sentence production (e.g., Loverso et al., 1979)

b) The relationship between lexical retrieval and sentence production is inconsistent (e.g., Mitchum & Berndt, 1994; Berndt et al., 1997b)

c) The functional and grammatical roles are important for production of sentences (e.g., mapping therapies, Saffran et al., 1994)

d) There is a need for a theory of rehabilitation (Hillis, 2001).

e) We do not know what our therapy is actually targeting and what process is improving (e.g., Riddoch and Humphreys, 1994).

The results challenge the proposal that linguistic similarity enhances generalisation (e.g., Thompson et al., 1997).

In the literature, the production of incomplete sentences has been explained by an inability to access the argument structure in a production task. For example, Kim and Thompson (2000) examined grammaticality judgment, verb naming and verb categorization in seven patients with agrammatism. They found that the patients had a problem in verb categorization. The authors suggest that verb categorization requires knowledge of both lexical and syntactic information, resulting in a poor performance in the patients. They conclude "agrammatic aphasic subjects show difficulties accessing the lemma level of representation of verb argument structure properties when conscious recall of the information is required to self-generate a verb label or a rudimentary syntactic structure" (p. 16). Kim and Thompson (2000) suggested two places in Bock and Levelt's model of sentence production that could result in inaccurate sentence production: a) at the lemma retrieval stage and b) at the lexeme retrieval stage. According to Kim and Thompson, failure at the lemma retrieval level would result in poor realization of the argument structures during narrative production while failure at the lexeme level would result in sentences with noun phrases but no verbs.

In Study 1, P1 produced sentences with incomplete arguments with or without a verb. Therefore P1 did not show a demarcated pattern (i.e., only incomplete argument structure or only absence of verbs) that would be consistent with impairment at the lemma retrieval stage or at the lexeme retrieval stage. There are thus two possible explanations for the production of incomplete sentences. First, the verb lemma is impoverished. Second, retrieval of lexemes is impaired.

9.4 Contribution to knowledge

Study 1 and Study 1A add to the existing body of information on the relationship between intervention and aphasic language performance. The results of the two studies in this thesis have implications for GEM. The implications are discussed in three parts:

1) first, the relationship between verb retrieval and sentence production proposed by GEM;
2) second, the generalisation patterns predicted by GEM; and
3) third, the processes that are important for sentence production as proposed by GEM.

Verb retrieval and sentence production: Study 1 and Study 1A failed to demonstrate a consistent relationship between verb retrieval and sentence production. The production of incomplete sentences provides evidence for a possible link between verb retrieval and sentence production because the arguments produced (e.g., subject, direct object) indicate the activation of the verb lemma. The variability in the performance patterns among the participants was too great to reach a unanimous conclusion about the nature of the relationship between verb retrieval and sentence production. In Study 1A, P8 had a poor ability to produce verbs in isolation in comparison to the other participants but produced the greatest number of sentences in response to the intervention (i.e., to the verb argument module). Study 1 and Study 1A support Mitchum and Berndt's (1994) hypothesis that additional factors besides verb retrieval may affect the production of sentences. Verb affix retrieval as an additional factor is ruled out by Study 1 and Study 1A because a direct relationship between verb affix retrieval and sentence production was not seen. The additional factors that may affect the production of sentences include an impoverished lemma, retrieval of planning frame and specification of grammatical and functional roles.

Prediction of generalisation patterns: GEM is unable to pinpoint the processes that were targeted by the intervention task. The implication is that GEM needs to be more detailed in the specification of the processes required for sentence production to be able to predict the generalisation patterns in patients with aphasia.

Processes important for sentence production: The results of the experimental intervention in Study 1 indicated that additional impairments besides verb retrieval, verb affix retrieval and sentence representation play a role in impaired sentence production. The results of Study 1A imply that GEM may be correct that activation of the arguments by a verb lemma is necessary for sentence production, but simply providing appropriate arguments is not sufficient for sentence production. Study 1A implies that GEM lacks the detail to explain additional steps involved in the process of verb lemma activation that are necessary for sentence production.

The present studies, in association with the clinical aphasiology literature (e.g., mapping therapy studies) suggest that one of the major components of intervention focusing on improving sentence production should be making the argument roles explicit. In other words, the specification of functional roles (e.g., agent, theme) and grammatical roles (e.g., subject, object) at the functional level of GEM may be one of the crucial processes for production of sentences.

To summarise, there are three implications for GEM. First, there is not a consistent relationship between verb retrieval and sentence production. Second, GEM needs to be more detailed in the specification of the processes required for sentence production and the effect of therapeutic tasks on the required processes to be able to predict the generalisation patterns in patients with aphasia. Third, the processes of sentence production proposed by GEM are important for sentence production but processes different from or in addition to the proposed processes play a role in the production of sentences. The processes crucial for sentence production may vary in patients depending upon the level of impairment.

9.4.1 GEM and other theories

Using GEM, the lack of generalisation from verb retrieval to sentence production in Study 1 can be explained on the basis of two possible loci of impairment, a) impoverished lemma and b) impaired lexeme retrieval for production. Different patients with aphasia may have one of these processes impaired or a combination of these resulting in poor sentence production. An impoverished lemma would activate the arguments of the target verb incompletely resulting in production of incomplete sentences. Thus, an impoverished lemma would result in incomplete information at all levels of the model. Impaired lexeme retrieval would act as a hurdle in accessing the word form of the target words resulting in similar symptoms of incomplete sentences. Despite the explanation, we cannot specify one explanation in an individual because the affected production processes involved in the impoverished lemma are not known.

GEM is a combination of concepts selected from models of sentence production by Garrett (1984), Lapointe and Dell (1989), Bock and Levelt (1994) and Levelt et al. (1999). Thus, all these models would explain the lack of generalisation from verb retrieval to sentence production in a similar way as described above.

Explanations within GEM: The lack of generalisation from verb retrieval to sentence production can be explained by mapping theory (Saffran et al., 1994) that is based on the various models of sentence production and applies to GEM. Mapping theory focuses on functional and grammatical roles (see Chapter 4). The important aspect of specifying functional and grammatical roles at the functional level was not included in the intervention task in the studies in this thesis. The importance of focusing on functional and grammatical roles is supported by studies such as Schneider and Thompson (2003) that specified the roles of the verb arguments and found generalisation to sentence production.

Another possibility is that the prosodic information present in the phonological representation of the verb (i.e., information at the positional level) that provides important information about word class and clause and phrase boundaries was absent in the stimuli used in the present interventions (Marshall et al., 1988, p. 178).

Theories other than GEM: Two theories considered to explain the results of the present study are Kolk's (1995) proposal and the connectionist models (e.g., Chang, Griffin, Dell & Bock, 1997, cited in Dell, Chang & Griffin, 1999). Kolk (1995) describes agrammatic sentence processing as a timing disorder. In this framework, there are two main aspects. The first aspect is the assumption that every element needed to build a sentence representation has some activation that determines the availability of that element. It takes some time for elements to reach a critical level of activation and after a peak level, the activation is subject to decay. The decayed activation results in unavailability of the elements. The second aspect is synchrony among the different elements to be activated. For instance, information about the subject of the sentence must be active in order for the right form of the verb to become activated. Thus, the inability of the participants to produce all arguments of the verb after the lemma activation could be a result of decay of the information activated by the verb lemma. In other words, though the verb lemma activated the information about the argument structure, the information about the direct object might have been lost and as a result be unavailable because of decay.

The connectionist models (e.g., Plaut & Kello, 1999; Christiansen & Chater, 2001) explain sentence processing using artificial neural networks. There are three different types of units: input, output and hidden units that are interconnected to receive and send information. The pattern of activation set up by a network is determined by the weights, or strength of connections between the units. Weights may be either positive or negative. A negative weight represents the inhibition of the receiving unit by the activity of a sending unit. An example of a connectionist model of sentence production is the structuralist priming model (Chang, Griffin, Dell & Bock, 1997, cited in Dell, Chang & Griffin, 1999).

Chang et al. (1997, cited in Dell et al., 1999) make three basic assumptions about production (p. 532):

a) First, production starts with a message expressing propositional content
b) Second, message elements may differ in their accessibility and these differences contribute to structural choices
c) Third, words are selected one at a time and the processing is incremental and left-to-right.

Chang et al. suggest that differences in conceptual accessibility (implemented by having the features of one role more activated than others) determined the target structure of the sentences during training in their implemented model (p. 533). Chang et al. (1997, cited in Dell et al., 1999) used this model to explain structural priming. Structural priming refers to the tendency of a speaker to repeat the structures of previously uttered sentences irrespective of the difference in the conceptual content (Bock, 1986).

Applying the results to the present study, the speculation is that in terms of production, the differences in conceptual accessibility that may have followed from the strength of activation might have resulted in incomplete sentences. The strength of the connections between the units would influence the processing of information from one unit to another. It is possible that some information got lost in some participants because of a negative weight or because of a weak activation. The negative weight could be due to an impaired process such as impaired role assignment at the functional level of GEM.

Considering structural priming, there should be priming of sentence structure (i.e., SVO and SVOO) in the present study but the amount of priming is inversely related to the amount of computational resources (Hartsuiker and Kolk, 1998). Another possibility in relation to structural priming could be that the target sentence sets precedence for the participants to produce that structure and when the participant is unable to produce a similar structure, self-monitoring may result in inhibition of output (Marshall et al., 1988, p. 178).

Therefore, impaired processes might affect the strength of connections between two units (i.e., receiving and sending) or between two levels (e.g., functional and positional). Similarly, the activation might depend upon the computational resources available at that particular point in time. This would explain the lack of generalisation from verb retrieval to sentence production seen in Study 1. The severity of language impairment in certain participants (e.g., P3, P4) would explain the weak connections in these participants resulting in a lack of improvement seen in the trained items. Incomplete sentences produced might be due to the information lost and unavailable because of decay of the information. Thus, other factors such as computational resources, availability of information and the strength of connections in addition to the information present at different levels of GEM may affect the production of sentences in patients with aphasia.

9.5 Limitations of the study

Three limitations were noted in the studies in this thesis. The first limitation arose from variables related to the number of trained items. The number of trained items was ten in each module. The proposed number of verbs was low because inclusion of more items would have increased the length of the intervention and a further increase in the intervention would not have been feasible. The length of the intervention was long despite the low number of verbs because of the three modules of intervention. The low number of trained items may have been one reason for the lack of generalisation seen from trained to untrained items.

The second limitation was heterogeneity. Heterogeneity of participants may have influenced the results in Study 1. Participants with a range of language skills were chosen to assess the effect of a model-based intervention on patients with different severity of aphasia. However, two of the participants were unable to repeat a sentence and therefore, the chosen intervention task was not suitable for all the participants. A test for repetition ability should thus have been one of the inclusion criteria.

The third limitation was a lack of a functional communication assessment. Inclusion of a functional communication assessment was overlooked. A functional communication assessment was essential to evaluate the effect of intervention in participants with severe language impairment to see if these participants improved in areas that the standard tests were not designed to assess. Two of the participants (P4 and P6) with low scores on the standard tests did not improve in their ability to produce sentences. Nevertheless, they benefited from the intervention in certain ways for which only anecdotal evidence in the form of comments by family members and friends was present to support a clinically significant change (see Appendix H).

9.6 Clinical implications

The findings of Study 1 and Study 1A have clinical implications for speech and language therapists involved in the rehabilitation of patients with aphasia. Clinical implications will be discussed in relation to the two studies followed by implications for factors important for the success of an intervention and implications for model-based intervention.

The clinical implications for the use of model-based intervention for sentence production disorders in patients with aphasia are five.

- First, training both at the word level and at the sentence level is likely to result in maximum response generalisation in patients with impaired lexeme retrieval. Study 1 indicates that the processes required to produce a word in isolation may be different from the processes required to produce the same word in a sentence.
- Second, specification of argument roles is important for sentence production. Study 1A indicates that information about verbs and the verb arguments is important for producing a sentence. Furthermore, Study 1A indicates that mere presentation of arguments is not helpful in improving sentence production for all the participants. Studies that have included *specification* of argument roles (e.g., Schneider and Thompson, 2003; Marshall et al., 1998) have found generalisation from verb retrieval to sentence production. These studies, along with the results of Study 1A, indicate that information about verb arguments needs to be made explicit for patients with aphasia to improve sentence production.
- Third, patients with aphasia with impairment restricted to one level of a model may respond successfully to such an intervention. Factors that may play an important role in the performance of an individual include: a) severity of the language impairment in terms of the language profile on a

standard aphasia test; b) performance on the pre-intervention test battery and c) features of the intervention task.

- Fourth, the intervention is likely to be successful if the task correlates with the impaired process i.e., if a person has impaired lexeme retrieval, then the intervention task should focus on lexeme retrieval. Both the features of the intervention task and the level of impairment need to be taken into account. From the results of these two studies, it is clear that the participants who showed an improvement in sentence production had impaired lexeme retrieval as their locus of impairment. Patients with impaired lexeme retrieval only, with other processes intact, were good candidates for intervention such as the one in the current study because a part of the intervention focused on lexeme retrieval.
- Fifth, the application of CNP models to treatment of impaired language is limited to focusing therapy and providing directions for the therapy target. The studies in this thesis indicate that CNP models are able to account partially for the performance patterns for patients with aphasia with relatively normal language but not for patients who fall below a certain threshold in their abilities. For example, patients with severe language impairment or patients with more than one impaired process responded in a manner different from the one predicted by GEM. The results of the studies in this thesis strongly suggest that GEM lacks sufficient detail about the steps and timing in the cognitive processes that are essential to sentence production in patients with aphasia.

9.7 Suggestions for future research

The findings in this thesis have implications for future research. There are implications for research in areas such as understanding the relation between process and intervention, effect of an intervention focusing on functional and grammatical roles, evaluating the differential effect of intervention focusing on teaching rules versus no rules, specifying details of intervention tasks in terms of the instruction given and the target of the intervention task, selection of stimuli, and interpretation of a change in scores on tests used for the assessment of language impairment.

Research focusing on the effect of intervention on a particular process that is impaired in an individual with aphasia would help in understanding the relationship between process and intervention. Research focusing on the effect of intervention specifying functional roles and grammatical roles would be helpful for a better understanding of the proposed processes crucial for sentence production. The differential effect of an intervention focusing on rules versus intervention not teaching rules can be illuminating for the selection of an intervention task because the intervention task can have a remarkable effect on the outcome of therapy. A comparison of intervention tasks and studying the effect of variation of instructions on the responses of patients with aphasia would help in determining the specific instruction model meaningful for the research question asked. Selection of stimuli is another concern that would benefit from study of verbs categorised semantically and/or syntactically. Measurement of test-retest reliability measures for language assessment tests (such as the BDAE) and the psycholinguistic tests (such as the Verb Production Battery and the PALPA) would be beneficial for interpretation of a change in scores on these tests.

9.8 Conclusions and summary

The conclusions of this thesis are:

- Presentation of verbs and verb arguments are not sufficient to help patients with aphasia to produce a sentence.
- GEM does not predict the performance patterns of participants with a poor baseline because GEM is not detailed enough to explain the processes impaired in an individual.
- Model-based intervention (such as the one in this study) can be beneficial for participants with impairment at one level of the model.
- The success of an intervention can be enhanced by matching the locus of impairment with the features of the intervention task.

Summary: The aim of this thesis was to analyse the effects of a model-based intervention on the production of sentences in patients with aphasia in order to evaluate the significance of the results for the theoretical validity of the grammatical encoding model of normal sentence production (GEM). Study 1 informs us that training at the word level does not generalise to production of sentences. Study 1A informs us that verb arguments are important for sentence production but not sufficient. Clinically, these studies imply that a model-based intervention such as the one in these studies may be beneficial for participants whose impairment matches the intervention task. The studies emphasise the complexity of the process of sentence production and highlight the practical difficulties of attempting to segregate the effect of different variables on sentence production.

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Appendix A

Pictures used in Study 1, 1A and 1B.

This appendix contains all the pictures used in Study 1 and in the extensions Study 1A and Study 1B.

1.1 Verbs

A total of thirty verbs were used with ten verbs in the trained category and twenty verbs in the untrained category. On each page there are two pictures, A and B that were used in different combinations for different modules of intervention. Picture A was used in the word module. Picture A and B in combination were used in both the affix module and sentence module.

The pictures for verbs are presented in the following groups:

Verbs 1-10 Trained verbs in Study 1

Verbs 11-20 Untrained verbs in Study 1 and used as trained verbs in Study 1A

Verbs 21-30 Untrained verbs in Study 1 and Study 1A

Verbs 31-34 Verbs added/changed

1.2 Nouns

A total of thirty nouns were used with ten nouns in the trained category and twenty nouns in the untrained category. On each page there is one picture that was used for all three modules of intervention.

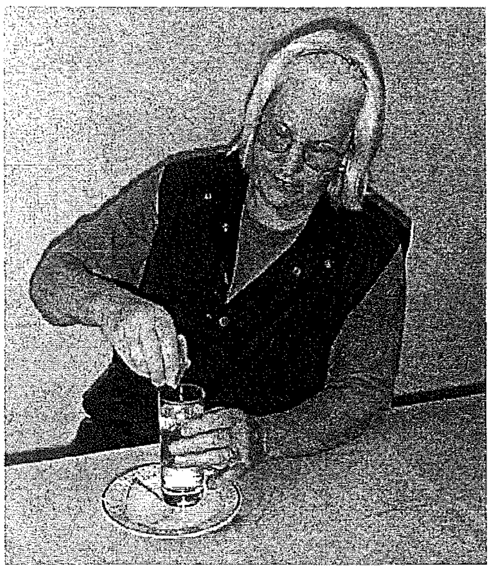
The pictures for nouns are presented in the following groups:

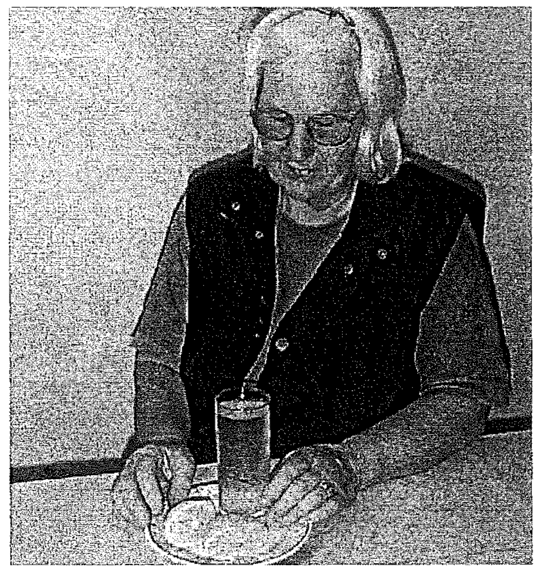
Nouns 1-10 Trained nouns in Study 1

Nouns 11-30 Untrained nouns in Study 1

Verb 1 Squeeze. Trained verb in Study 1.

Verb forms: squeeze, squeezed, the woman squeezed a lemon.

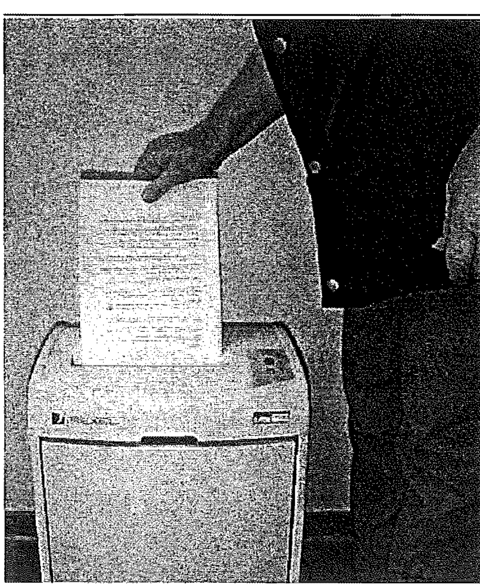


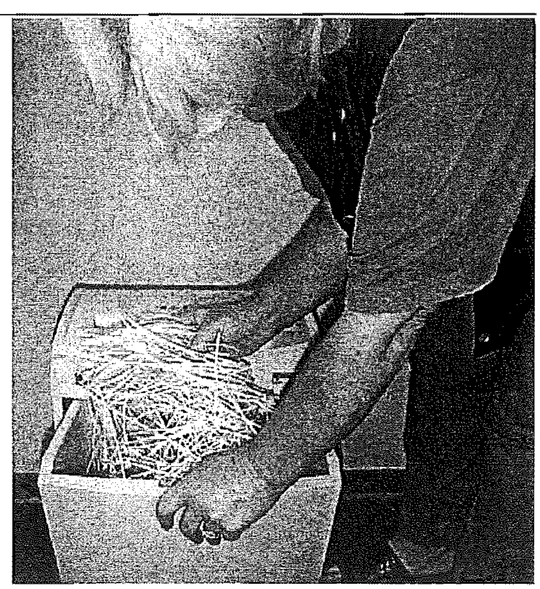


A B

Verb 2. Shred. Trained verb in Study 1.

Verb forms: shred, shredded the woman shredded some paper.

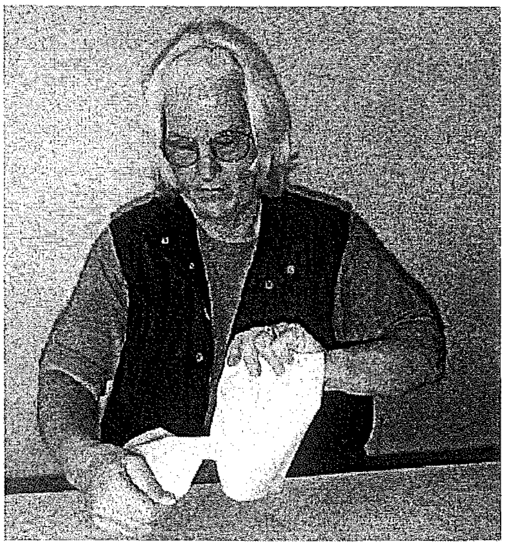




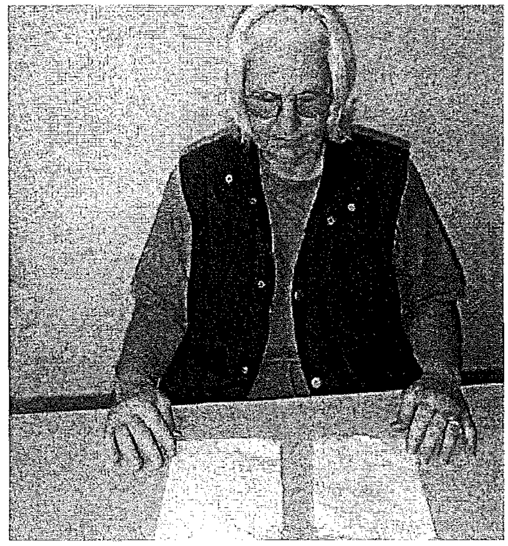
A B

Verb 3. Tear. Trained verb in Study 1.

Verb forms: tear, tore, the woman tore a piece of paper.



A

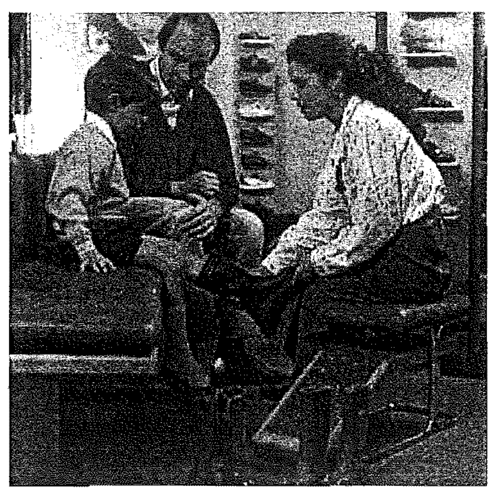


B

Verb 4. Choose. Trained verb in Study 1.

Verb forms: choose, chose, the boy chose a pair of boots.

A

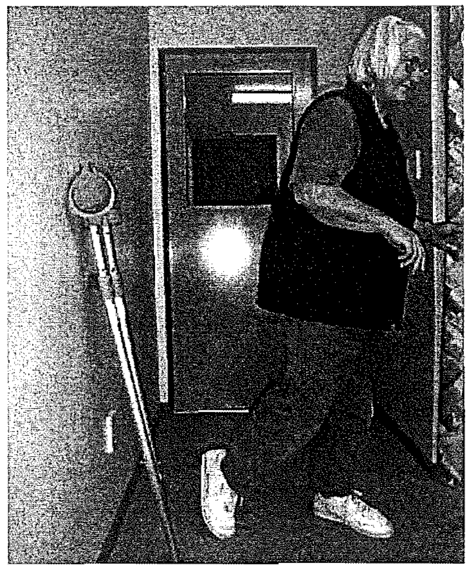


B

Verb 5 Lean. Trained verb in Study 1.

Verb forms: lean, leaned, the woman leaned a crutch against the wall.

A

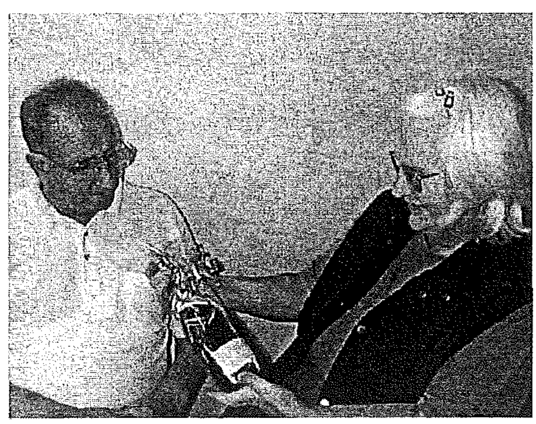


B

Verb 6. Give. Trained verb in Study 1.

Verb forms: give, gave, the man gave the woman a bottle of wine.

A



B

Verb 7 Ask. Trained verb in Study 1.

Verb forms: ask, asked, the woman asked the man a question.

A

B

Verb 8. Spread. Trained verb in Study 1.

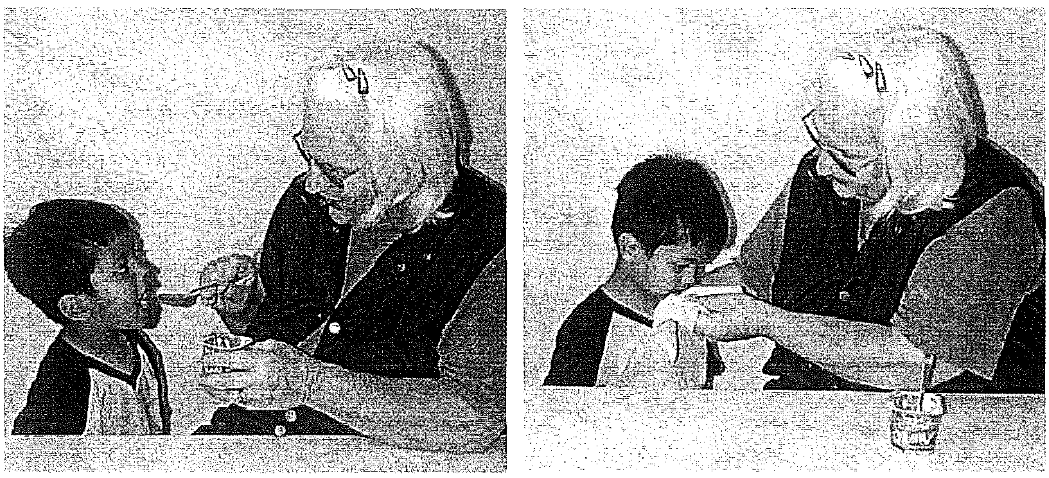
Verb forms: spread, spread, the woman spread jam on the bread.

A

B

Verb 9 Feed. Trained verb in Study 1.

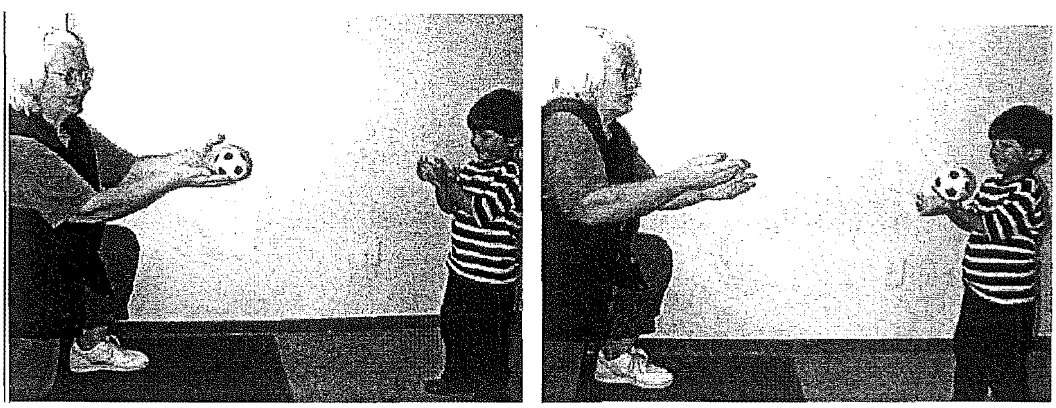
Verb forms: feed, fed, the woman fed yoghurt to the boy.



A B

Verb 10. Throw. Trained verb in Study 1.

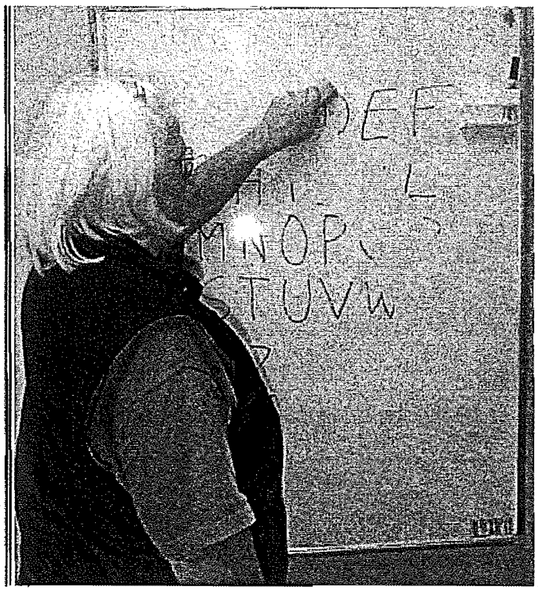
Verb forms: throw, threw, the woman threw a ball to the boy.



A B

Verb 11. Wipe. Untrained verb in Study 1 and trained verb in Study 1A.

Verb forms: wipe, wiped, the woman wiped the board.

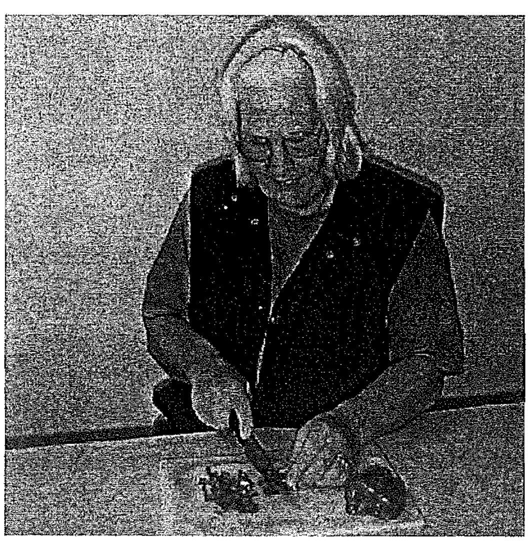


A

B

Verb 12. Chop. Untrained verb in Study 1 and trained verb in Study 1A.

Verb forms: chop, chopped, the woman chopped a pepper.



A

B

Verb 13. Sort. Untrained verb in Study 1 and untrained verb in Study 1A.

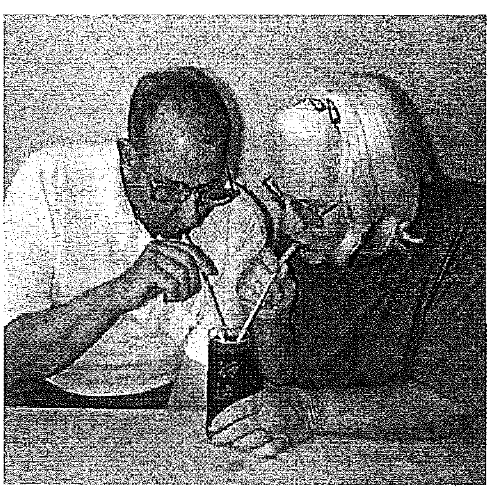
Verb forms: sort, sorted, the woman sorted the money.

A

B

Verb 14. Share. Untrained verb in Study 1 and untrained verb in Study 1A.

Verb forms: share, shared, the couple shared a drink.

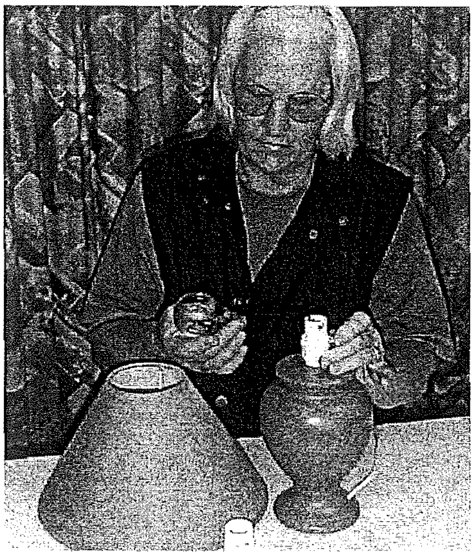
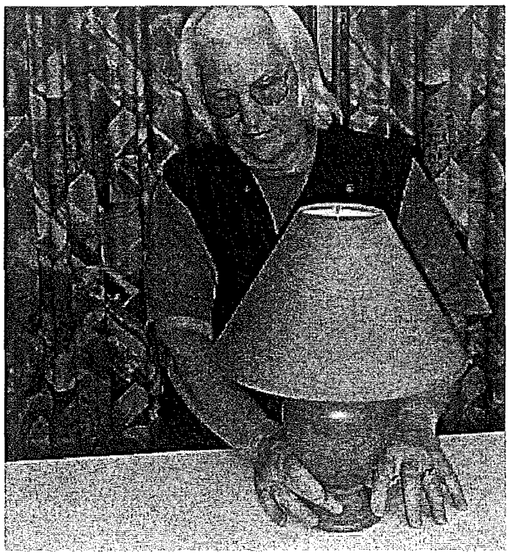


A

B

Verb 15 Assemble. Untrained verb in the Study 1 and trained verb in Study 1A.

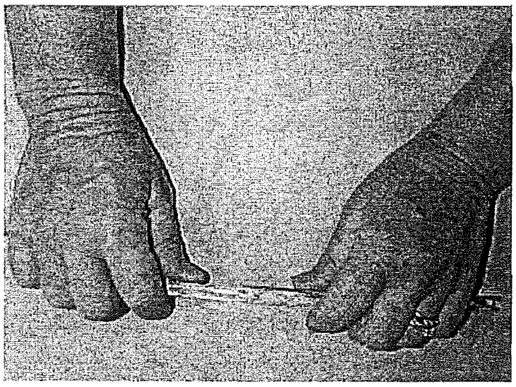
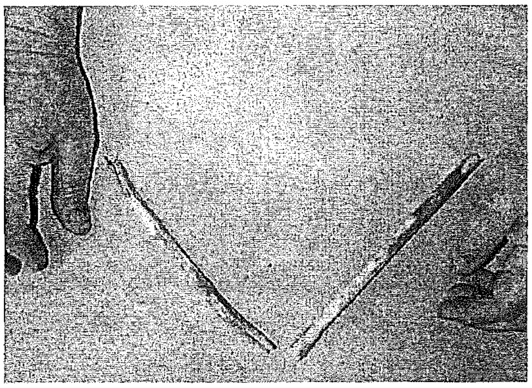
Verb forms: assemble, assembled, the woman assembled a lamp.

A B

Verb 16. Break. Untrained verb in the Study 1 and trained verb in Study 1A.

Verb forms: break, broke, the woman broke a stick.

A B

Verb 17. Make. Untrained verb in Study 1 and untrained verb in Study 1A.

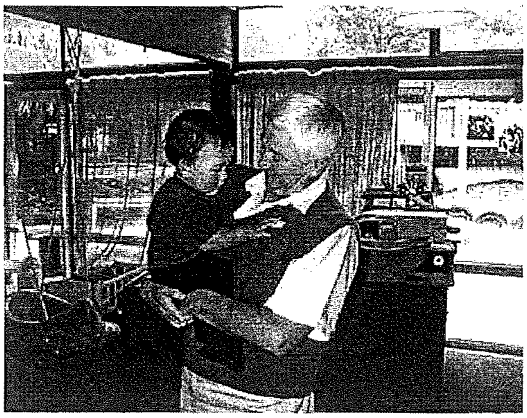
Verb forms: make, made, the boy made a castle.

A

B

Verb18. Hold. Untrained verb in Study 1.

Verb forms: hold, held, the woman held the baby.

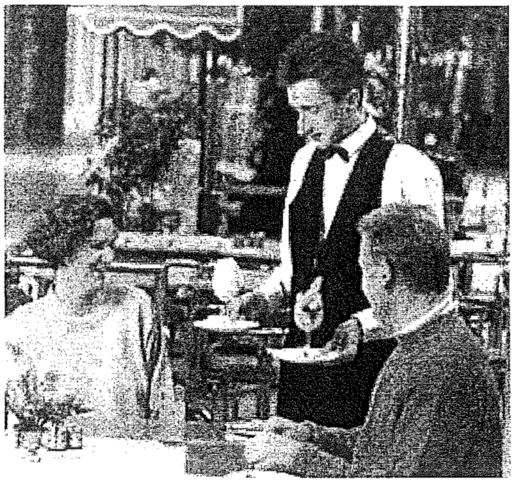


A

B

Verb 19. Serve. Untrained verb in Study 1 and untrained verb in Study 1A.

Verb forms: serve, served, the woman served them the dessert.

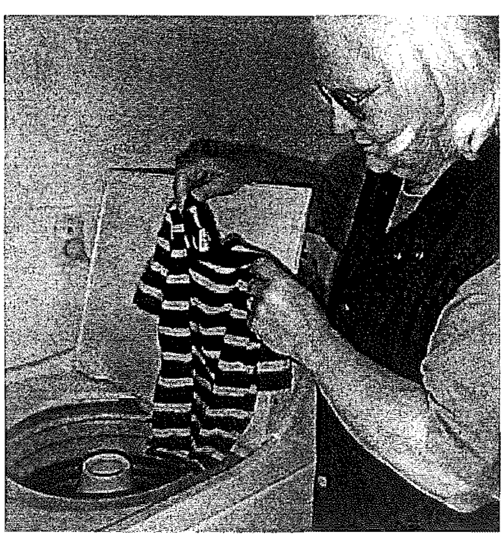


A

B

Verb 20. Wash. Untrained verb in Study 1 and trained verb in Study 1A.

Verb forms: wash, washed, the woman washed a t-shirt for the boy.



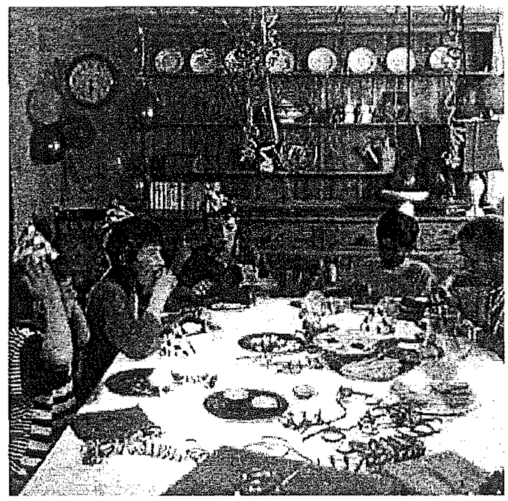
A

B

Verb 21. Organize. Untrained verb in Study 1 and trained verb in Study 1A.

Verb forms: organize, organized, the woman organized a birthday party for her son.

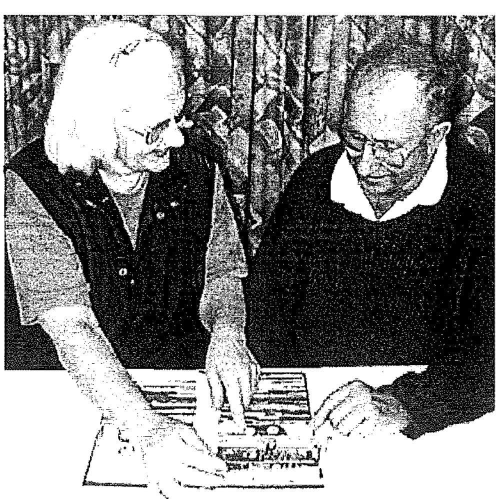
A



B

Verb 22. Show. Untrained verb in Study 1 and untrained verb in Study 1A.

Verb forms: show, showed, the woman showed the man some photographs.



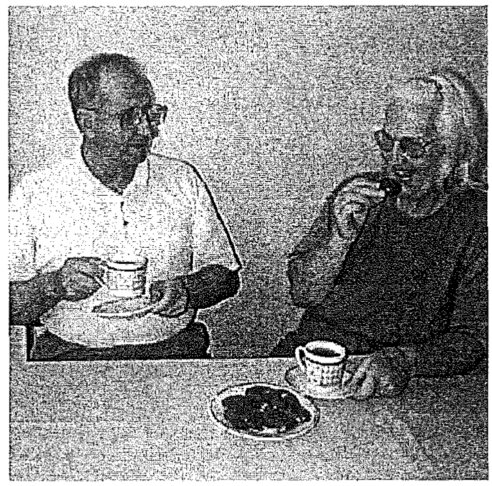
A

B

Verb 23. Offer. Untrained verb in Study 1 and trained verb in Study 1A.

Verb forms: offer, offered, the woman offered the man a biscuit.

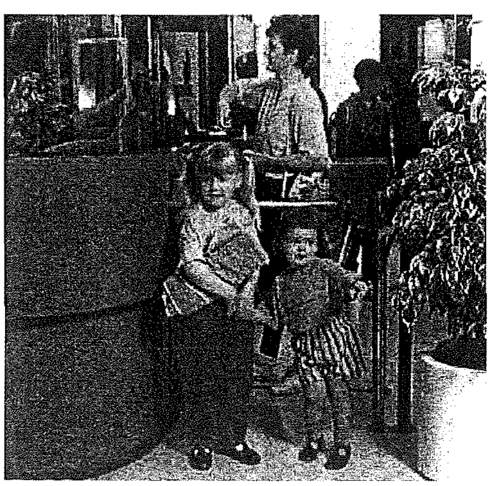
A



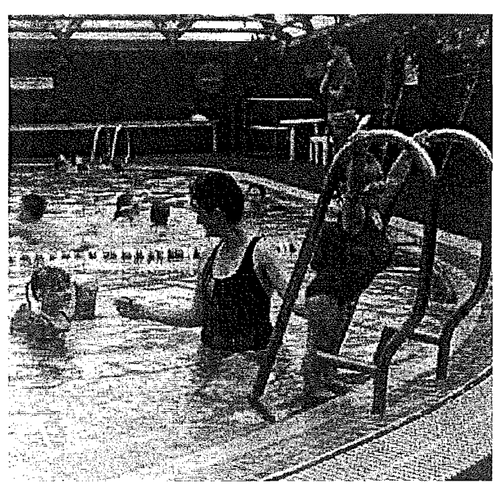
B

Verb 24. Take. Untrained verb in Study 1.

Verb forms: take, took, the woman took the children to the swimming pool.



A



B

Verb 25. Read. Untrained verb in Study 1 and trained verb in Study 1A.

Verb forms: read, read, the woman read the boy a story.

A B

Verb 26. Buy. Untrained verb in Study 1 and trained verb in Study 1A.

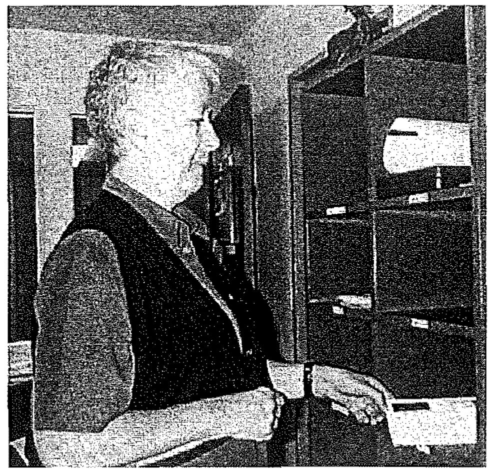
Verb forms: buy, bought, the man bought boots for his son.

A B

Verb 27. Send. Untrained verb in Study 1 and untrained verb in Study 1A.

Verb forms: send, sent, the woman sent her a letter.

A



B

Verb 28. Build. Untrained verb in Study 1 and untrained verb in Study 1A.

Verb forms: build, built, the woman built a tower for the boy.

A

B

Verb 29 Hang. Untrained verb in Study 1.

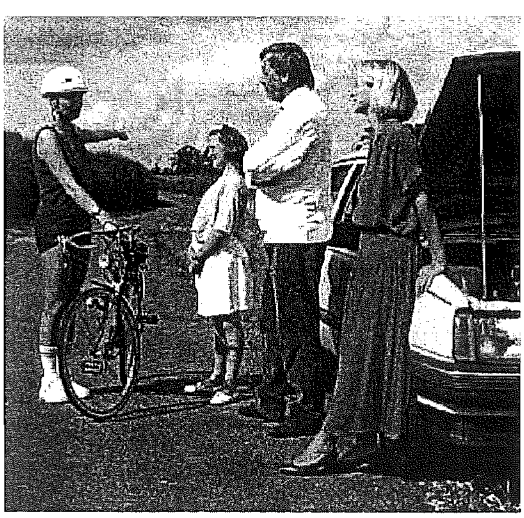
Verb forms: hang, hung, the woman hung a jacket on the hook.

A

B

Verb 30. Tell. Untrained verb in Study 1.

Verb forms: tell, told, the woman told them the way.

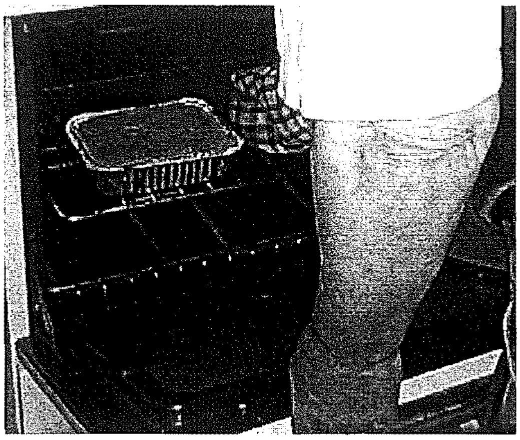


A

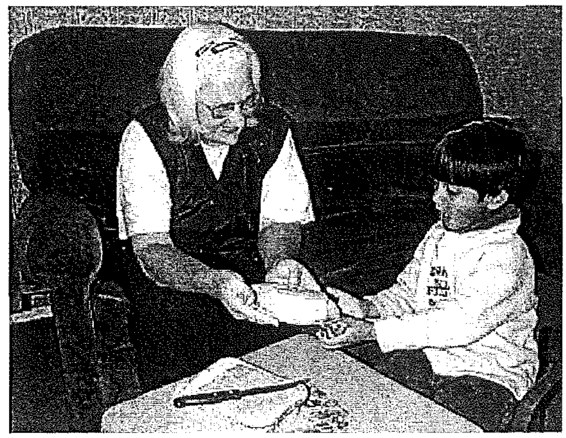
B

Verb 31. Bake. Trained verb in Study 1A and untrained verb in study 1A.

Verb forms: bake, baked, the woman baked a cake for the boy.



A

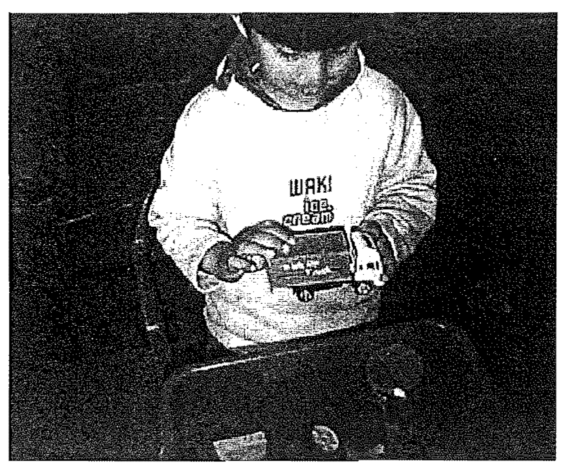


B

Verb 32. Find. Untrained verb in Study 1A.

Verb forms: find, found, the boy found a truck.

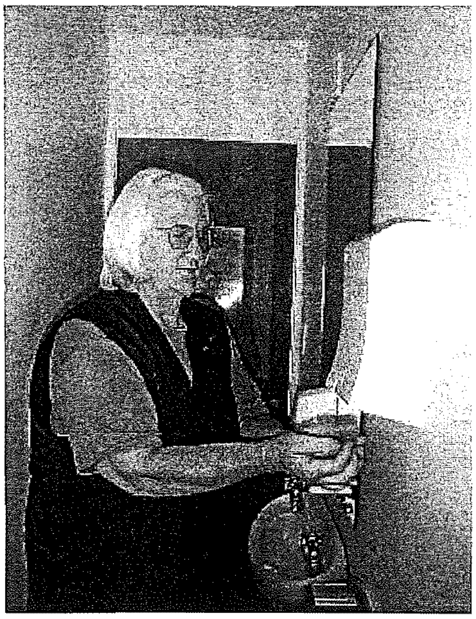
A



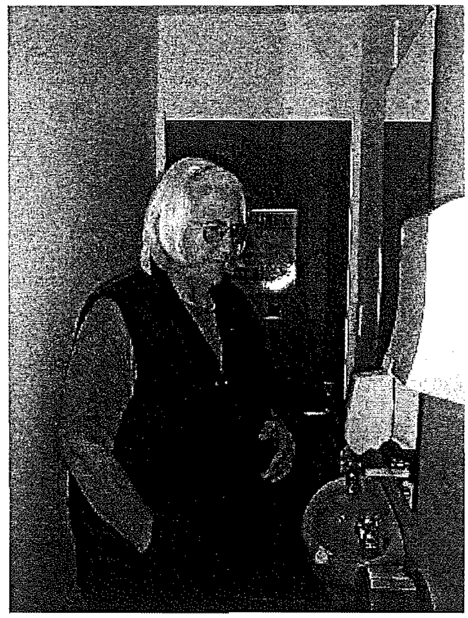
B

Verb 33. Dry. Untrained verb in Study 1A.

Verb forms: dry, dried, the woman dried her hands.



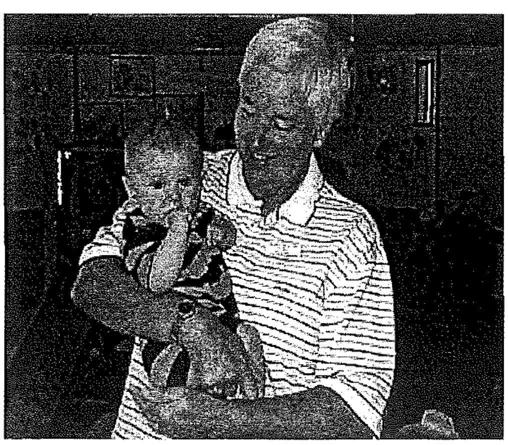
A



B

Verb 34. Hold. Trained verb in Study 1A.

Verb forms: hold, held, the woman held the baby.



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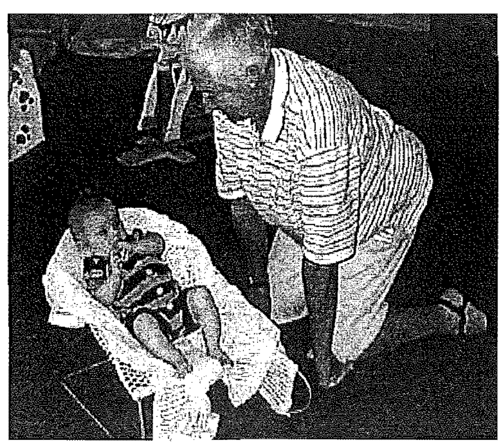


B

Noun 1 Chef. Trained noun in Study 1.

Noun forms: Chef, Chef's, the chef's meal is tempting

Noun 2 Cobbler. Trained noun in Study 1.

Noun forms: Cobbler, Cobbler's, the cobbler's shop is messy.

Noun 3 Cow. Trained noun in Study 1.

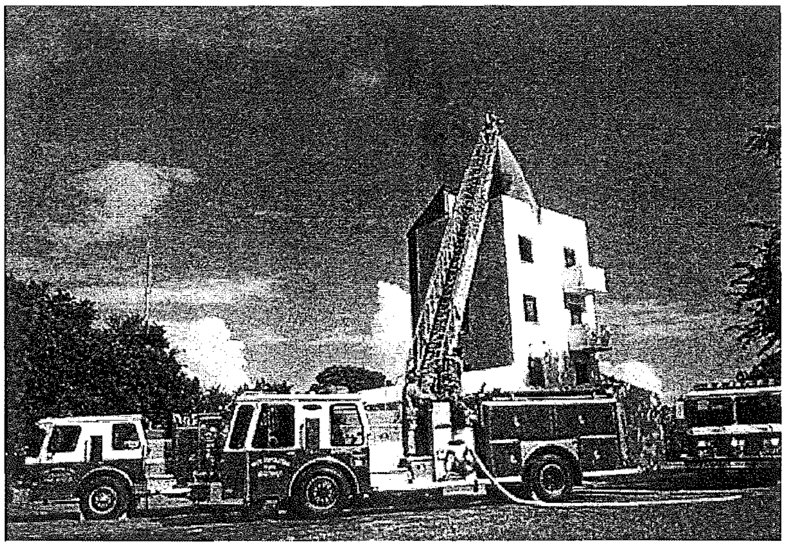
Noun forms: cow, cow's, the cow's face is black.

Noun 4. Donkey. Trained noun in Study 1.

Noun forms: donkey, donkey's, the donkey's face is big.

Noun 5. Fire-engine. Trained noun in Study 1.

Noun forms: fire-engine, fire-engine's, the fire-engine's ladder is high.



Noun 6. Florist. Trained noun in Study 1.

Noun forms: florist, florist's, the florist's bouquet is beautiful.

Noun 7. Girl. Trained noun in Study 1.

Noun forms: girl, girl's, the girl's hair is wet.

Noun 8. Man. Trained noun in Study 1.

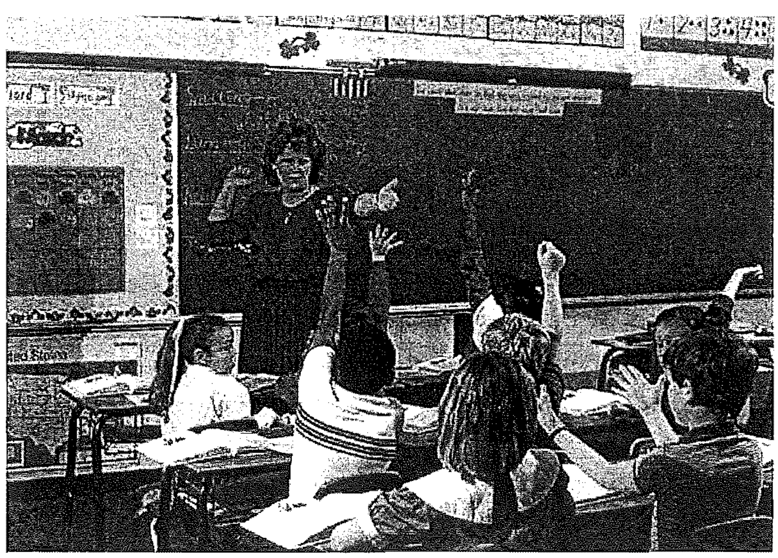
Noun forms: man, man's, the man's arm is hurt.

Noun 9. Postman. Trained noun in Study 1.

Noun forms: postman, postman's, the postman's bag is open.

Noun 10. Teacher. Trained noun in Study 1.

Noun forms: teacher, teacher's, the teacher's class is active.



Noun 11. Artist. Untrained noun in Study 1.

Noun forms: artist, artist's, the artist's painting is big.

Noun 12. Cleaner. Untrained noun in Study 1.

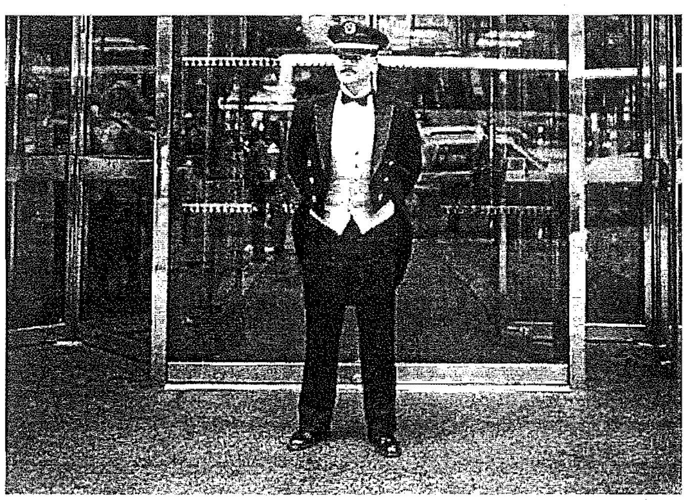
Noun forms: cleaner, cleaner's, the cleaner's machine is huge.

Noun 13. Dentist. Trained noun in Study 1.

Noun forms: dentist, dentist's, the dentist's drill is sharp.

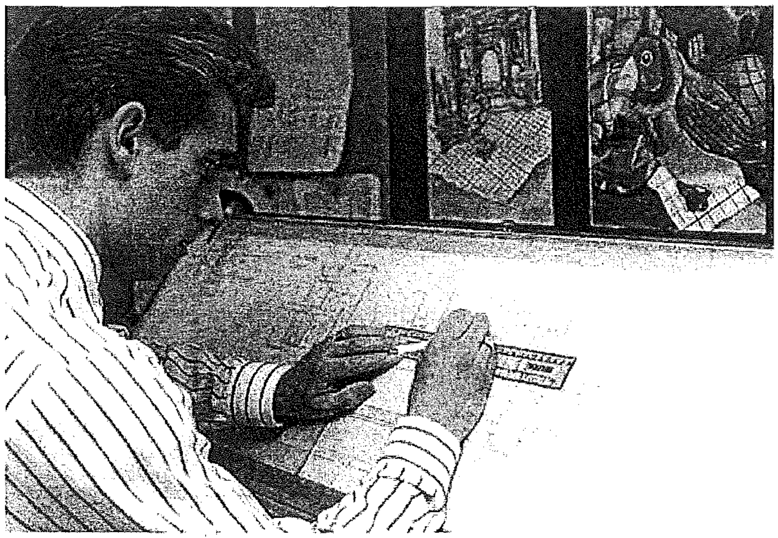
Noun 14. Doorman. Trained noun in Study 1.

Noun forms: doorman, doorman's, the doorman's uniform is smart.



Noun 15. Draftsman. Untrained noun in Study 1.

Noun forms: draftsman, draftsman's, the draftsman's work is detailed.



Noun 16. Fisherman. Untrained noun in Study 1.

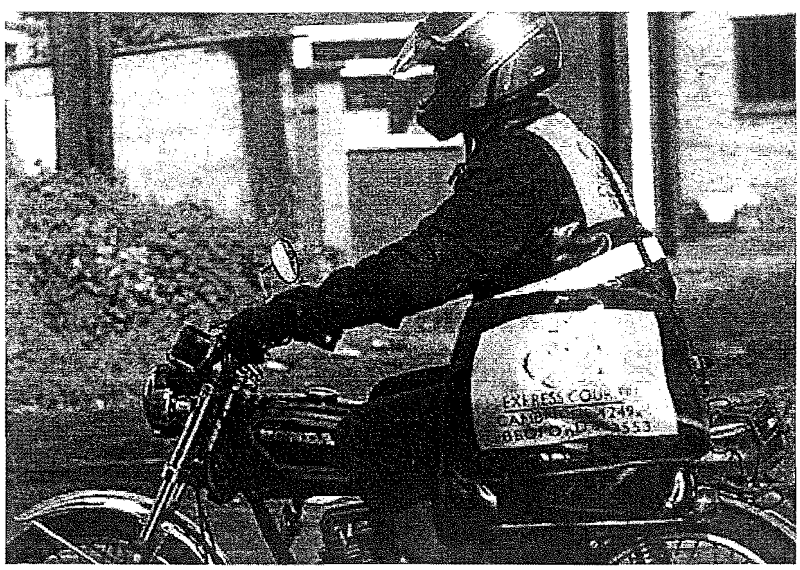
Noun forms: fisherman, fisherman's, the fisherman's catch is big.

Noun 17. Gardener. Trained noun in Study 1.

Noun forms: gardener, gardener, the gardener's hoe is long.

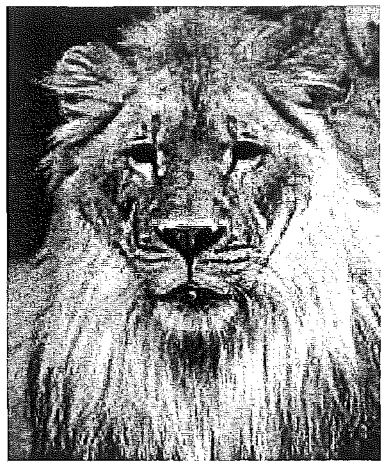
Noun 18. Messenger. Untrained noun in Study 1.

Noun forms: messenger, messenger's, the messenger's bag is full.



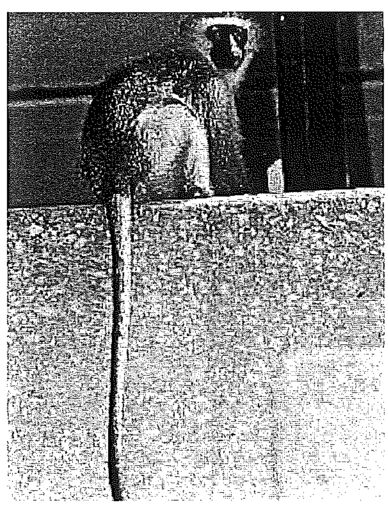
Noun 19. Lion. Trained noun in Study 1.

Noun forms: lion, lion's, the lion's mane is hairy.



Noun 20. Monkey. Trained noun in Study 1.

Noun forms: monkey, monkey's, the monkey's tail is long.

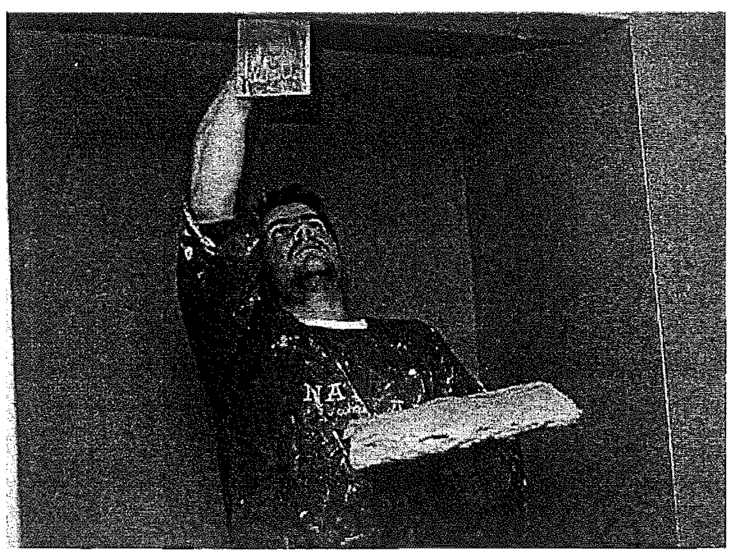


Noun 21. Patient. Trained noun in Study 1.

Noun forms: patient, patient's, the patient's face is calm.

Noun 22. Plasterer. Trained noun in Study 1.

Noun forms: plasterer, plasterer's, the plasterer's shirt is dirty.

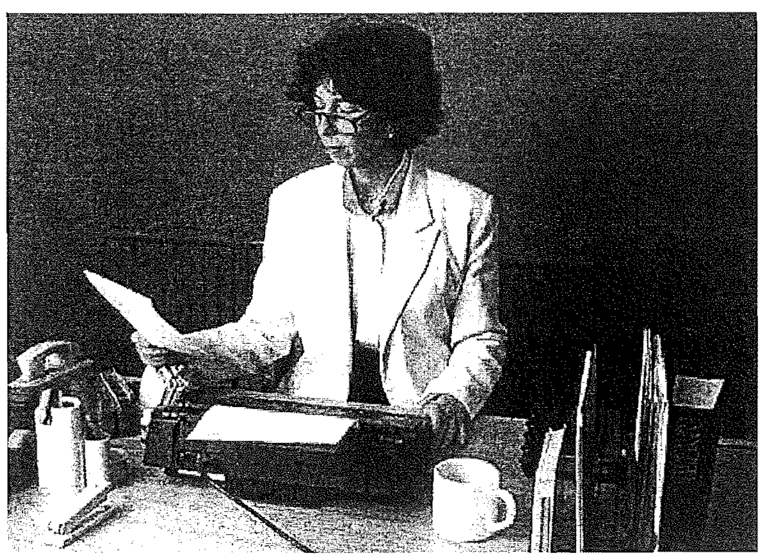


Noun 23. Roofer. Trained noun in Study 1.

Noun forms: roofer, roofer's, the roofer's job is risky.

Noun 24. Secretary. Trained noun in Study 1.

Noun forms: secretary, secretary's, the secretary's desk is organised.

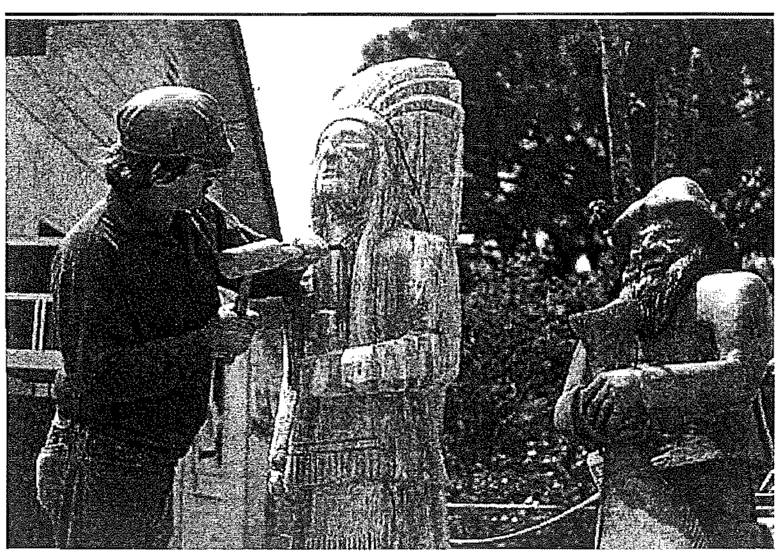


Noun 25. Soldier. Trained noun in Study 1.

Noun forms: soldier, soldier's, the soldier's truck is big.

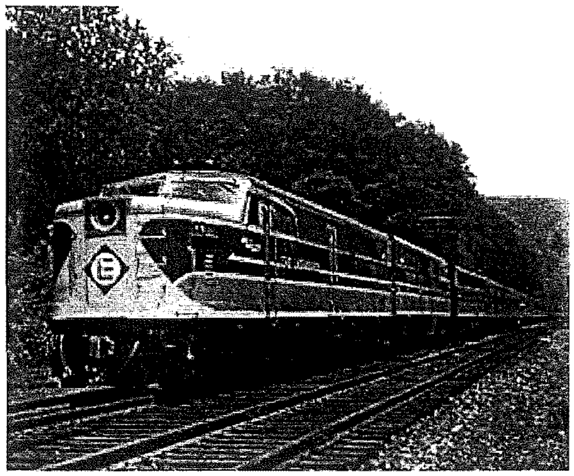
Noun 26. Woodcarver. Trained noun in Study 1.

Noun forms: woodcarver, woodcarver's, the woodcarver's figure is intricate.



Noun 27. Train. Untrained noun in Study 1.

Noun forms: train, train's, the train's design is modern.

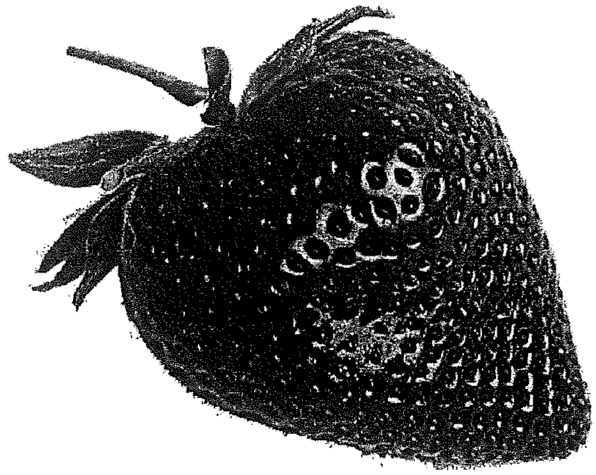


Noun 28. Reporter. Untrained noun in Study 1.

Noun forms: reporter, reporter's, the reporter's camera is huge.

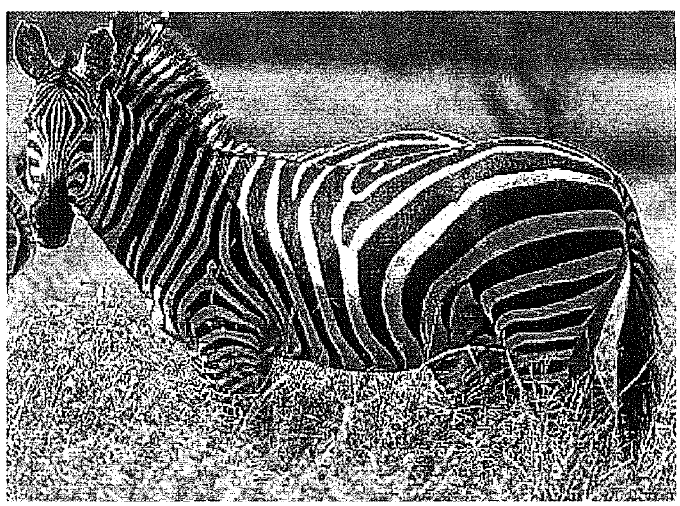
Noun 29. Strawberry. Untrained noun in Study 1.

Noun forms: strawberry, strawberry's, the strawberry's skin is shiny.



Noun 30. Zebra. Untrained noun in Study 1.

Noun forms: zebra, zebra's, the zebra's coat is striped.



Appendix B

Specific instructions for obtaining baseline data at the three different levels in Study 1, for obtaining baseline data for affix level and sentence level in Study 1A, and for obtaining data at the three levels, word, affix and sentence in Study 1B.

1.1 Baseline instructions

1.1.1 Word level

1.1.1.1 Verbs

I am going to show you some pictures today and I will ask you about some things that are happening in the picture. For example, here in this picture, you will be asked to focus on the action (i.e. what is happening in this picture) and tell me one word for it, for example, in this picture the one word is 'give'. Do you understand? Do you have any questions? For this part, I will not tell you if your answer is correct or incorrect. Alright? Are you ready?

1.1.1.2 Nouns

I am going to show you some pictures today and I will ask you about some things about some people, animals or objects in the picture. For example, here in this picture, you will be asked to focus on the person (i.e. who is the person in this picture) and tell me one word for it, for example, in this picture the one word is 'designer'. Do you understand? Do you have any questions? For this part, I will not tell you if your answer is correct or incorrect. Alright? Are you ready?

1.1.2 Affix level

1.1.2.1 Verb-affixes

Now, I am going to show you two pictures in a sequence and I will ask you to focus on the action again. Here you have to focus on the action in the first picture and at the same action in the second picture. You will be asked to say one word for what the person did. For this part, I will not tell you if your answer is correct or incorrect. Alright? Are you ready?

1.1.2.2 Noun-affixes

Please look at this picture. This picture is about a dog and his bowl. I will ask you a question like "whose bowl?" and you will be expected to say "dog's bowl". Do you understand? For this part, I will not tell you if your answer is correct or incorrect. Alright? Are you ready?

1.1.3 Sentence level

1.1.3.1 Verb sentences

Now, we are going to look at the same pictures again but we will focus on forming a sentence for example, 'she stirred the coffee' is a sentence where I am telling you what happened in the picture. Now, please look at these pictures and I will ask you to make a sentence describing what the person did in the picture. Ready?

1.1.3.2 Noun sentences

Look at this picture and make a sentence. Here you have to pay attention to the person in the picture e.g. the designer. The sentence has to be in the format, 'The designer's work is complicated'. Another example is 'the librarian's book is interesting'. Now, please look at these pictures and I will ask you to make a sentence. Ready?

Appendix C

Specific instructions for experimental intervention in Study 1 (the main study).

1.1 Experimental intervention

1.1.1 Word module

You will be presented with a picture of an action/object followed by a spoken word. You have to say 'yes' if the picture and the spoken word match and 'no' if they do not. Are you ready?

1.1.2 Affix module

1.1.2.1 Verbs

You will be presented with a picture of an action followed by a spoken word. Here the focus is on the action that the person in the picture already finished. For example, this picture shows the action that is happening like 'stir' and this picture shows that the person finished the action, so the word is 'stirred'. You have to say 'yes' if the picture and the spoken word match and 'no' if they do not. Are you ready?

1.1.2.2 Nouns

You will be presented with a picture of an object or person followed by a spoken word. Here the focus is on the object/person in the picture and the object associated with that person, for example, librarian's book. You have to say 'yes' if the picture and the spoken word match and 'no' if they do not. Are you ready?

1.1.3 Sentence module

1.1.3.1 Verbs

Now you will be shown the same pictures (already presented) but you will be asked to focus on forming a sentence here. First I will show you a sequence of two pictures and say a sentence. If the picture and the spoken sentence match, please say 'yes' and if they do not match, please say 'no'. Are you ready?

1.1.3.2 Nouns

Now you will be shown the same pictures (already presented) but you will be asked to focus on forming a sentence here. First I will show you a picture and say a sentence. If the picture and the spoken sentence match, please say 'yes' and if they do not match, please say 'no'. Are you ready?

D APPENDIX D

Appendix D supplements the information on linguistic analysis of speech in chapter 2 (section 2.3.5). This appendix contains the following details:

D.1 Categorisation of normal sentences as proposed by Crystal (1982)

D.2 Description of the LARSP analysis

D.3 Variables measured in Language Assessment Remediation and Screening Procedure (LARSP)

D.4 Criteria used for segmentation of speech samples for normal speakers and people with aphasia

D.5 Transcript conventions

Categorisation of normal sentences is described mainly to differentiate the types of response seen in normal speakers. The categorisation is followed by explanation of the different types of information obtained from the different analysis using Computerised Profiling and LARSP. The information in the different LARSP variables is obtained using formulae as listed in Table D.1 and is depicted in Figure D.1. For a linguistic analysis, the language sample needs to be segmented into units based on defined criteria and one of the areas of debate in this context is the use of pause to segment samples. The difficulty of segmenting the sample into analyzable utterances is resolved by a set of criteria for segmentation of speech samples for both the normal population and for individuals with aphasia. Finally, a list of transcript conventions explains the way speech samples have been transcribed for all participants.

D.1 Categorisation of Normal sentences (Crystal, 1982)

Crystal distinguishes between major and minor sentences. Major sentences have a subject-predicate structure (e.g. *John went to the market*) and minor sentences (e.g., *Yes. Oh! Hello.*) do not. Crystal (1982: 42) describes four possible ways of responding normally:

1. A minor sentence which is syntactically non-productive e.g., *yes, thanks, mhm, Jack and Jill went up the hill*
2. A full major sentence which is appropriate to the grammatical stimulus and has a subject-predicate structure e.g. *that is a boy*
3. An elliptical major sentence i.e., the use of an incomplete, but grammatically predictable major sentence e.g., *to town* (in response to *Where are you going?*).
4. A reduced major sentence i.e., a sentence where elements have been left out due to the immaturity or inaccuracy of the patient's speech (Crystal, 1982: 43). These types of sentences can be found in the speech sample of a person with aphasia. Depending on the characteristics of that particular patient, a person with aphasia may omit verbs or nouns. For example,

    T: *what's happening?*

    P: *man in garden.*

In the current study, participants are instructed to describe what is happening in a picture. This instruction should result in the production of minor, full major and reduced major sentences rather than elliptical major sentences as direct questions are not being asked to elicit the sample.

Crystal (1982: 42) also describes two types of abnormal grammatical response: zero response and structural abnormality. In a zero response, the therapist gives the patient time to respond but the patient does not say anything. In structural abnormality, the grammatical pattern of patient's response does not match that required by the therapist's stimulus. These responses follow questions. For example, when a noun is given instead of an expected verb (*T: what does the car do/P: man*).

D.2 Description of the LARSP analysis

LARSP is a Language Assessment, Remediation and Screening Procedure that is based on *A Grammar of Contemporary English* (GCE, Quirk et al, 1972). According to Crystal et al., LARSP emphasizes functional relationships between the different elements of structure at clause level (Crystal, Fletcher & Garman, 1982: 39). Moreover, the "organization of this grammar in terms of levels (of sentence, clause, phrase, word) … permits a direct and economical description of the data of syntactic disability…" (Crystal, Fletcher & Garman, 1982: 39). In LARSP, three main levels of sentence structure are recognized:

a) patterns of sentence and clause structure
b) patterns of phrase structure
c) patterns of word structure

Language samples can be computer analysed for syntax using Computerised Profiling (CP. Long et al., 2002). CP performs an automatic LARSP analysis that an examiner can manually check. CP uses LARSP to yield the following information about the speech samples using LARSP:

1) A verb valency analysis (Fletcher, 1985) presents the lexical verbs used by an individual alongside a representation of the syntactic frame in which the verbs were used. It also produces a summary analysis of verb transitivity. The verb valency analysis categorises verbs based on the syntactic framework of the sentences the verbs are produced in. Therefore, the categorization automatically tells the researcher the number of clause elements produced in context of that particular verb. If a ditransitive verb is produced with only one object, it will be classified as a transitive verb. If the speaker does not produce any arguments of a verb (e.g., *sweep*), then it is categorised as an intransitive verb.
2) A verb-form analysis (Fletcher, 1985) shows in detail the auxiliary and copular forms as well as the verbal inflections used by an individual.
3) A lexical analysis (Fletcher & Garman, 1988) details the lexemes used by an individual in each of the grammatical categories.

D.3 Variables measured in LARSP

The different variables measured for spontaneous speech are listed in Table D.1. Variables that are calculated using formulae are defined in terms of these formulae.

A LARSP chart (see Figure D.1) has four sections and a profile chart for different stages. Section A makes a note of sentences that cannot be analyzed in conventional grammatical terms. Sections B, C and D display patterns of grammatical interaction between the therapist and the patient (see Figure D.1). Spontaneous sentences/utterances are those that are produced without any stimulus from the therapist (Crystal, 1982).

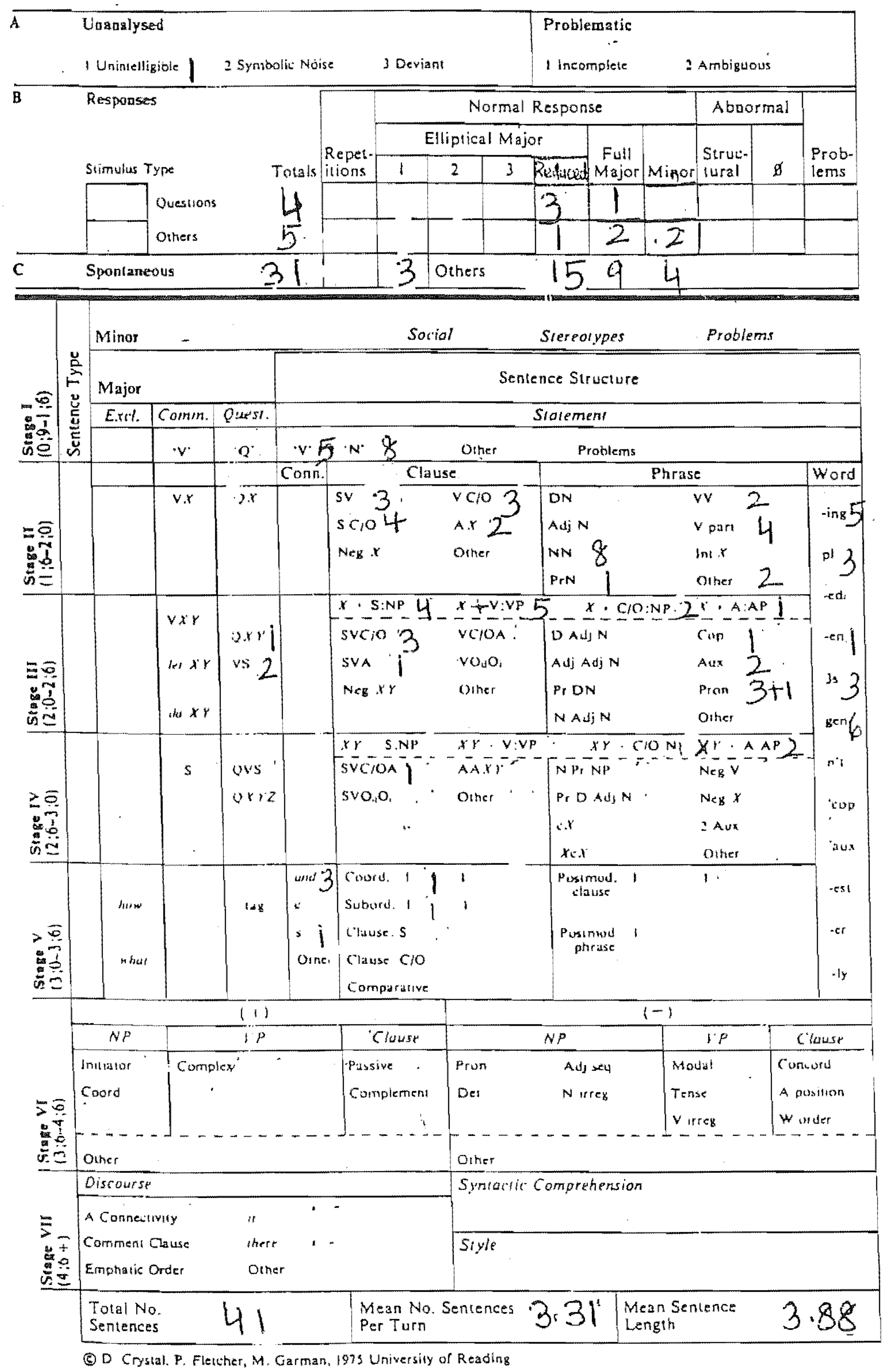
Stages I-VII represent the seven stages in the learning of sentence structure. Each stage has an approximate chronological age range for its acquisition by normal children (Crystal, 1982). Though the grading of stages is based on norms of child development, these stages are valid for adults and it has been found that the assessment of a disability and its subsequent remediation in an adult with a syntactic disorder can be carried out using the same scale of syntactic development (Crystal, Fletcher and Garman, 1976: 31).

Table D.1. Definition of LARSP variables measured in this thesis.

Variable	Formula
Total utterances	Total utterances in corpus transcript file minus null responses
Spontaneous utterances	Number of utterances in section C of the LARSP chart
Unanalyzed utterances	Total utterances in section A under unanalyzed
Problematic utterances	Total utterances in section A under problematic
MLU in words	Total words (items separated by a space, excluding contractions) in P sentences divided by the total number of utterances
Verb phrases expanded	Number of expanded verb phrases divided by the total number of verb phrases
Syntactic complexity score	Calculated only for multi-word utterances. "The measure is based on the number of grammatical categories combined in an utterance, and these categories are subject, verb, object and complement" (Blake, Quartaro and Onorati, 1993: 143).
Clausal complexity	Stage number (1-7) multiplied by the number of structures for that stage divided by the total number of major utterances
Phrase complexity	Stage number (1-6) multiplied by the number of phrases for that stage divided by the total number of major utterances
Stage I clause	Utterances consist of single words or word-like units
Stage II clause	Two element structures fall in this category
Stage III clause	Three element structures fall in this category

Variable	Formula
Stage IV clause	Utterances of four elements or more
Stage V clause	Utterances with complex sentence formation, defined in terms of clausal coordination, clausal subordination and phrasal subordination.
Stage VI clause	New types of constructions such as complex verb phrase and complementation structures, and errors made are noted in this stage.
Stage VII clause	Lists more advanced structure in relation to discourse, syntactic comprehension and style, e.g., patterns of sentence connectivity and emphatic expression, use of comment clauses.

Figure D.1. Example of a LARSP chart.



Profile Chart: normal adult

D.4 Criteria for segmentation of speech samples

Utterances are used rather than sentences as a segmentation unit because a verb is a crucial element of a sentence and patients with aphasia may not produce verbs in their speech. Utterances are divided in terms of pause, intonation and grammatical structures. Because pause functions somewhat differently for normal speakers and speakers with aphasia, we consider pauses before giving the detailed criteria for dividing samples into utterances.

D.4.1 Pause

In normal speakers, pauses during spontaneous creative speech represent the creative stage of formulation of language (Goldman-Eisler, 1968). According to Garrett (1982), the production system is time dependent (p. 23). A break in the fluency of an utterance occurs when the rate of speech output exceeds the rate of decision making or planning (p. 23). According to Crystal & Varley (1998), for normal speakers, pauses are more likely to occur between clauses than within clauses, and if a person does pause within a clause, the likelihood is that the pauses will occur between the main constituents of clause structure e.g., between subject and verb, and verb and object (p. 72). According to Miller (1981), in general, 80% of the pauses greater than 2 seconds will occur between utterances (p. 14).

In patients with aphasia, a pause often represents a failure to retrieve a form (Buckingham & Kertesz, 1974, Buckingham, 1979). Butterworth (1979) found that the mean delay before verbal paraphasias (e.g., *But I seem to be table you correctly, sir*) was reliably shorter than before neologisms; and neologisms phonologically related to a real word (e.g., *dok/talk*) or to a target show a mean delay reliably shorter than phonologically linked neologisms (e.g., *noks* and *mok*) (p. 148). Thus, depending upon the features present (i.e., paraphasia, neologism) in a patient's language, a pause may be long or short.

Crystal (1982) describes a four-term system to indicate the degrees of pause length in a transcript (p. 11). The degrees are brief (.); unit (equivalent to a pulse of a speaker's rhythm) (-); double (--); and treble (---). Longer pauses are categorized under treble. Pauses can be used to differentiate utterances in the normal population because in the normal population, "a pause along with a tone unit, divides the stream of speech into grammatically and lexically relevant sections" and lengthy pauses occur more often at the end of a spoken sentence (Quirk et al, 1972: 1049). But patients with aphasia may use long pauses irrespective of the position in an utterance and these pauses may be longer than a treble pause (e.g., in patients with lexical retrieval problems). Therefore, pauses cannot be used as reliable indicators to separate utterances in patients with aphasia (e.g., Saffran et al., 1989; Edwards, Garman & Knott, 1993).

D.4.2 Criteria for segmenting speech samples into utterances for the normal population

The cues that will be considered to segment normal speech into utterances will be pause, intonation and the grammatical completeness of the utterance. Grammatical completeness here means that the utterance falls into one of the normal response categories as described by Crystal (1982) and listed in section 1.1 above. If two or more clauses are joined by a coordinate conjunction without a separation by a long pause (treble), they will be scored as one utterance e.g., *he is reading a paper and she has gone through the door and he is sitting there very depressed looking.*

D.4.3 Criteria for segmenting speech samples into utterances for people with aphasia

D.4.3.1 Segmentation of a speech sample into utterances

a) The segmentation of a sample into utterances will be based on a combination of pause and intonation pattern with consideration of the clause structure. One clause structure with pause and appropriate intonation will be categorized as an utterance. A longer pause that is not a result of lexical retrieval difficulties in association with a falling intonation pattern for statements and *wh*-questions, and a rising intonation pattern for yes-no questions will be cues for segmentation into utterances. The intonation pattern will help to decide if a pause (probably) indicates a separate utterance. The clause structure of an utterance will be correlated with the normal response categories as defined by Crystal (1982). If an utterance is not a clause, then the utterance will be defined based on the syntax of the phrase structure e.g., o*n the tree, the black cat.*

b) If there is no pause between two clauses and they are joined by a subordinate or coordinate conjunction, they will be marked as one utterance e.g., *everyone is* *being because the boy has got the cake and mark is up and.* Two related clauses without a pause may occur in patients with aphasia, e.g., *she come back she upset.* These types of productions will be scored as one utterance.

c) Patients with aphasia with agrammatism and anomia differ in their spontaneous speech pattern output in terms of inflection and production of function words. Taking into consideration the pattern of their speech (Saffran et al., 1989), the grammatical completeness (Golinkoff & Ames, 1979) of an utterance (whether or not affixes, function words or nouns are present) will also be taken into account. For example, *uh he's gone to the people to the what you call uh fireman.* This will be coded as one utterance and later the reformulations (*to the people* and *what you call*) will be extracted, so that the utterance will be analysed as *he's gone to the fireman.*

D.4.3.2 Speech segments to be extracted during analysis

Mazes defined by Leadholm & Miller (1992) as false starts, repetitions, reformulations and filled pauses (p. 39) will be deleted.

d) False starts e.g., *(the man no) the lady is...*
e) Repetitions e.g., *the boy has got the (cake) cake*
f) Reformulation e.g., *the man is (in the uh) on the tree.*
g) Filled pauses e.g., *Umm, uh* and *er*

Revisions and repair will be considered mazes and only the final production of the sentence/utterance will be analysed even if the later version is less correct e.g., *she is (reading book) read a book* will be analysed as *she is read a book.*

D.4.3.3 Distorted/unintelligible words

h) Phonologically distorted words/paraphasias will be written as the actual words (if understood) e.g., *bree* for *tree* will be written as *tree.*
i) If the response is neologistic and unintelligible but can be clearly identified as a clause element in the sentence, it will be scored at the clause level e.g. *the man is on the buhuh.* In this utterance, *on the buhuh* will be coded as an adverb at clause level.
j) The neologisms will be coded as lexical errors. At the phrase level, neologisms will be coded as a noun (i.e., if the article or determiner indicates it is a noun)

verb (e.g., *she is brghn*) or an adverb (e.g., *his friend will come lastesz*) based on the syntax of the sentence and then coded as a lexical error.

D.4.3.4 Word finding

k) If the client is unable to say a word due to lexical retrieval, he will be given a score for a clause element at the clause level of analysis only.

l) At the error level the omission of the verb or the noun will be coded as a word finding error (WF)

D.4.3.5 Connectivity

Sometimes coordinate conjunctions (e.g., *and* and *so*) are used as a way of maintaining narrative flow and often *and* is attached to the end of a clause and followed by a pause, instead of their use as a regular means to link clauses (Crystal, Fletcher & Garman, 1982: 76). Taking this into consideration, LARSP has a separate place to score the use of conjunctions that do not link clauses. Thus, LARSP differentiates the use of "connecting devices" (p. 75) from the use of conjunctions as coordination. In a similar manner, use of other coordinate conjunctions (e.g. *but*) has been seen in one of the patients with aphasia in the current study.

m) In the current study, LARSP conventions for conjunctions will be followed. *But* and *and* will be analysed at phrase level only, if they introduce words or phrases. For example, a patient with nonfluent aphasia starts utterances with *but* or *and* e.g., *but pull over, but dog, and hat.* These utterances will be analyzed as cX.

D.4.3.6 Out of context comments

n) The out of context comments that are produced to comment about the picture instead of describing the picture will be analysed and coded at the error level as ambiguous error. For example, *I like that one, who does that one?* Utterances such as *who does that one* are different from utterances such as *what's that – a truck?* and therefore will be scored differently. The first utterance does not have an answer as a part of the utterance (e.g., *the dog* in this picture) to bring it into context and to indicate that this is a pattern of thinking aloud. The second utterance *what's that – a truck?* will be considered a part of the description of the picture as such instances are a pattern of thinking aloud and are found in the normal population. The use of 'ambiguous error' in this manner (for an out of context comment) is different from the intended use as specified in LARSP (i.e., this code is used when an error can be analyzed in more than one of the available error categories e.g. *he did fought*), but is an appropriate use of the code for aphasic speech.

D.4.3.7 Comment clauses

o) Utterances (e.g., *I think, I mean*) will be analysed as comment clauses and a detailed analysis of the comment clauses will not be done as they "have a limited potential for structural change" (Crystal, 1979: 102). Comment clauses will also include statements such as *I don't know* (even if they are not a part of the previous clause) as such statements are personal comments and are not a part of the description of the picture. The overall pattern of usage of such statements in a patient's speech sample will help decide if the utterance is a comment clause or not. The decision of not analysing comment clauses will result in a loss of negatives (e.g., n't) used in these statements but these negatives are not usually productive and do not reflect the usage of negatives in the description of the picture.

D.4.3.8 Incomplete utterances

p) Incomplete utterances will be coded as incomplete in the CORPUS[1] transcript. They will be analyzed and scored because they contain information about the vocabulary and the structure used. For example, *she is*... Incomplete utterances need to be manually counted because the computer program does not count utterances as incomplete once they have been analyzed.

D.4.3.9 Special considerations

Analysis of the speech samples will be done using Computerized Profiling. The use of a computer limits the way some of the utterances can be coded; for example, the

[1] CORPUS is the module used to create transcript files for all analysis modules in Computerized Profiling (CP), the program that is being used for LARSP analysis (Long, Fey & Channell, 2002).

use of a stage I code[2] does not allow the program to further analyze an utterance. If a patient says some words and uses a stereotype along with those words (e.g., *yes, hat and here beside,* where *here beside* is a stereotype for this particular patient), we can code the whole utterance as Stage I stereotype but this coding results in a loss of information about *yes* and *hat.*

q) To avoid losing information, stereotypes will be coded as a separate utterance. This will enable us to count the number of stereotypes that the patient has produced and also to find out if the intervention has resulted in a decrease in the number of stereotypes.

r) When there is neither a phrase nor a clause structure, then a list of nouns (even if it has one intonation pattern) will be scored as separate utterances, so as not to inflate the MLU or the Syntactic Complexity Score. They will not be added as stereotypes so as not to lose the nouns that the person is able to say e.g., *a dog, ladder a ryenjet.*

When necessary, utterances with more than one subordinate clause will be counted manually because of processing restrictions in CP for both the normal population and patients with aphasia e.g. *he laughed when he heard that the book was finished* (Long et al., 2002).

D.5 Transcript conventions

The rules for transcribing a speech sample are explained on the following page under transcript conventions.

---

[2] These codes include UT (unintelligible), SN (symbolic noise), DV (deviant), IC (incomplete), AB (ambiguous) and ST (stereotype).

Transcript Conventions

- Each CORPUS file may contain a maximum of 1000 utterances. This count includes both P and T utterances.

- Enter each utterance on a separate line. Use upper-case letters only for proper nouns and the pronoun "I". Do not capitalize the first word of an utterance. Do not number the utterances.

- If a P utterance contains more than 21 words, you must segment it and enter it on two lines. Both portions of the utterance should end with a legal punctuation mark (?!.^>) and the second half should begin with a tilde (~). Generally speaking, the best dividing point is at a clausal coordinator, e.g.

  uhhuh, and then my mom bought the wrong batteries so I can't use it.
  ~and it's been sitting under my bed for a long time.

  T utterances with more than 21 words should not be segmented.

- All utterances must be identified as spoken by P (patient, pupil, etc.) or T (teacher, therapist, etc.). Most of the program's analyses are performed on P utterances. However, it is possible to create a reversed CORPUS file (see help file on "Reverse P and T Utterances") in order to analyze T utterances. All T utterances must be preceded by "T: " (letter T, colon, space), e.g.

```
t: John, tell me what you see in the picture!
he's riding a bike.
```

- Utterances must end with one of the following five characters:
  - ? question
  - ! command
  - . statement
  - > interrupted utterance
  - ^ abandoned utterance

- Apostrophes, commas, asterisks, and parentheses are the only non-alphabetic characters permitted within an utterance. Words should not be hyphenated (upsidedown, merrygoround) and numbers should be spelled out without spaces (four, twentythree, sixhundredtwo).

  Apostrophes should be used only in contractions and the genitive (possessive) form of nouns. Do not use apostrophes to indicate indirect speech or casual speech forms (shortenings):

ACCEPTABLE	UNACCEPTABLE -->	ACCEPTABLE
I can't get it this one is Mommy's	I told him 'no' 'cause I want it	I told him no because I want it

  Commas should be used in the usual fashion to mark pauses, lists of nouns, and so on. It will improve the automatic analyses if you set off Minor portions of an utterance with commas:

```
Mommy, look at this!
I need another one, Judy.
ouch, I hit my thumb.
```

  All text enclosed in parentheses is treated as a maze and removed from the utterance when the transcript text file is converted into a CORPUS file. The entire utterance, including any mazes, is stored as a contextual note. For example:

```
(uh) can you give me (that thing) that pencil over there?
```

  is saved in the CORPUS file as

```
@ (uh) can you give me (that thing) that pencil over there?
can you give me that pencil over there?
```

  The default character to denote mazes is "@". A different character may be selected in the CP Preferences module.

- Omitted words can be entered with a leading asterisk. When saved in the CORPUS file, the omitted word is removed from the utterance but is retained in the preceding contextual note. For example:

```
the monster *is gonna get me.
```

is saved in the CORPUS file as

```
= the monster *is gonna get me.
the monster gonna get me.
```

- Any line that begins with a non-alphabetic character other than a left parenthesis (, asterisk *, or tilde ~ is stored as a contextual note. This feature can be used to enter notes about physical context, utterance glosses, gestures, etc. The recommended characters for marking contextual notes are: % & + = \ / : ; { } [ ] "

```
[T points to picture of cup]
t: what's this?
{P pretends to drink}
do this.
```

- Sometimes you may not be interested in the lexical or grammatical characteristics of T's language but only in the type of stimuli being provided to P and the nature of the T-P interaction. In these cases, rather than entering T's utterances verbatim you may wish to (1) enter utterance-final punctuation alone (. ? ! > ^) or (2) enter the codes used by the Conversational Acts Profile (i.e., CS, DA, RQIN, RQAC, RQCL, RQAT, RSCS, RSIN, RSAC, RSCL, RSAT) followed by final punctuation. If the CAP codes are entered in a CORPUS file they result in more accurate default choices by the CAP analysis module. Note, however, that either of these procedures will yield incorrect values for T's MLR.

normal transcription	final punctuation	CAP codes + punctuation
t: what's that you've got? that's my dog. t: let me see it! okay.	t: ? that's my dog. t: ! okay.	t: RQIN? that's my dog. t: RQAC! okay.

- If you will be doing a LARSP analysis of the transcript and want to analyze the occurrence of null responses to T stimuli, you must enter each such occurrence in the transcript as the word "null" followed by a period. For example:

```
t: Peter, what do you call this?
{P is preoccupied with the toy he's holding}
null.
```

Appendix E

Pictures used to elicit spontaneous speech

This appendix contains the five pictures used to elicit spontaneous speech samples. The pictures consisted of the cookie theft picture from BDAE, two scenes and two sequences of six pictures.

Picture 1: Cookie theft picture

Picture 2: Rescuing the cat

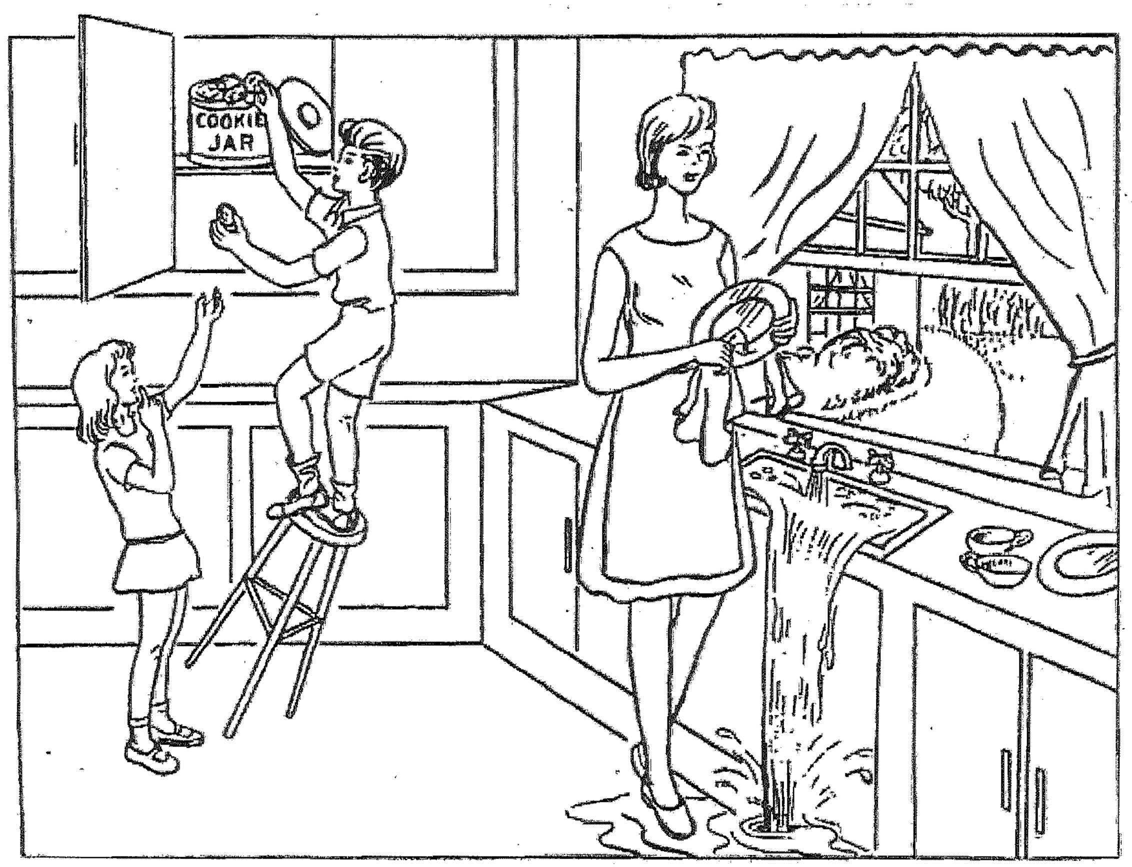
Picture 3: Birthday party mishap

Picture 4: Argument between a wife and a husband

Picture 5: Asking for directions

Picture 1

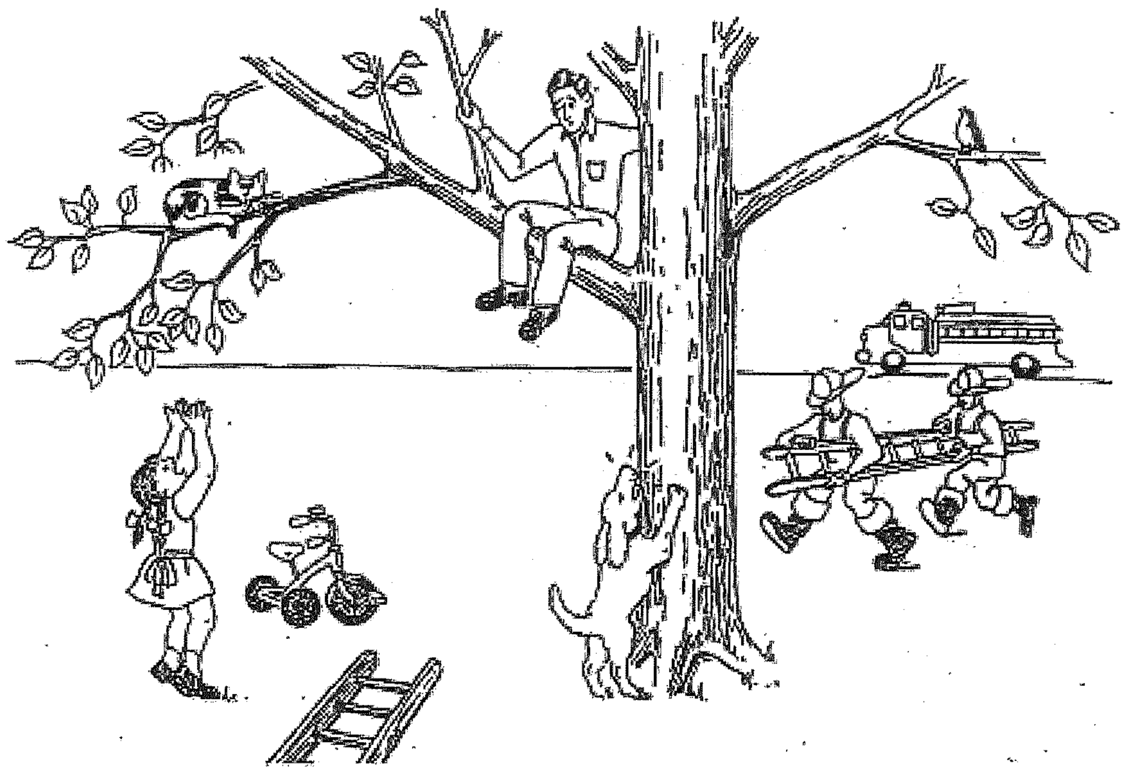
Cookie theft picture from the Boston Diagnostic Aphasia Examination (Goodglass, Kaplan and Barresi, 2001)[1].



[1] From "Boston Diagnostic Aphasia Examination (3rd edition)" by Goodglass, H., Kaplan, E. & Barresi, B. 2001. Copyright 2001 by Lippincott Williams and Wilkins. Reprinted with permission.

Picture 2

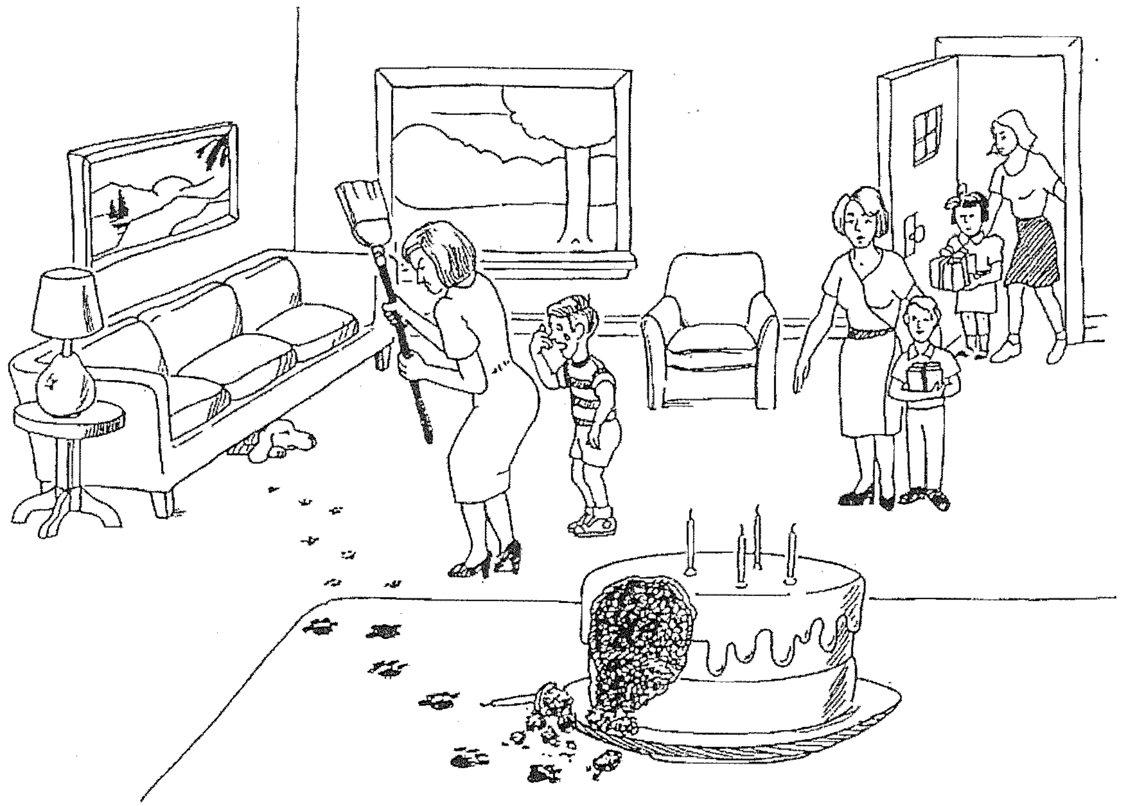
A scene about a man trying to rescue a cat[1].



[1] From "Test- retest stability of measures of connected speech in aphasia" by R.H. Brookshire and L.E. Nicholas, 1994, Clinical Aphasiology, 22, p. 121. Copyright 1994 by R.H. Brookshire and L.E. Nicholas. Reprinted without permission because of the inability to locate the authors.

Picture 3

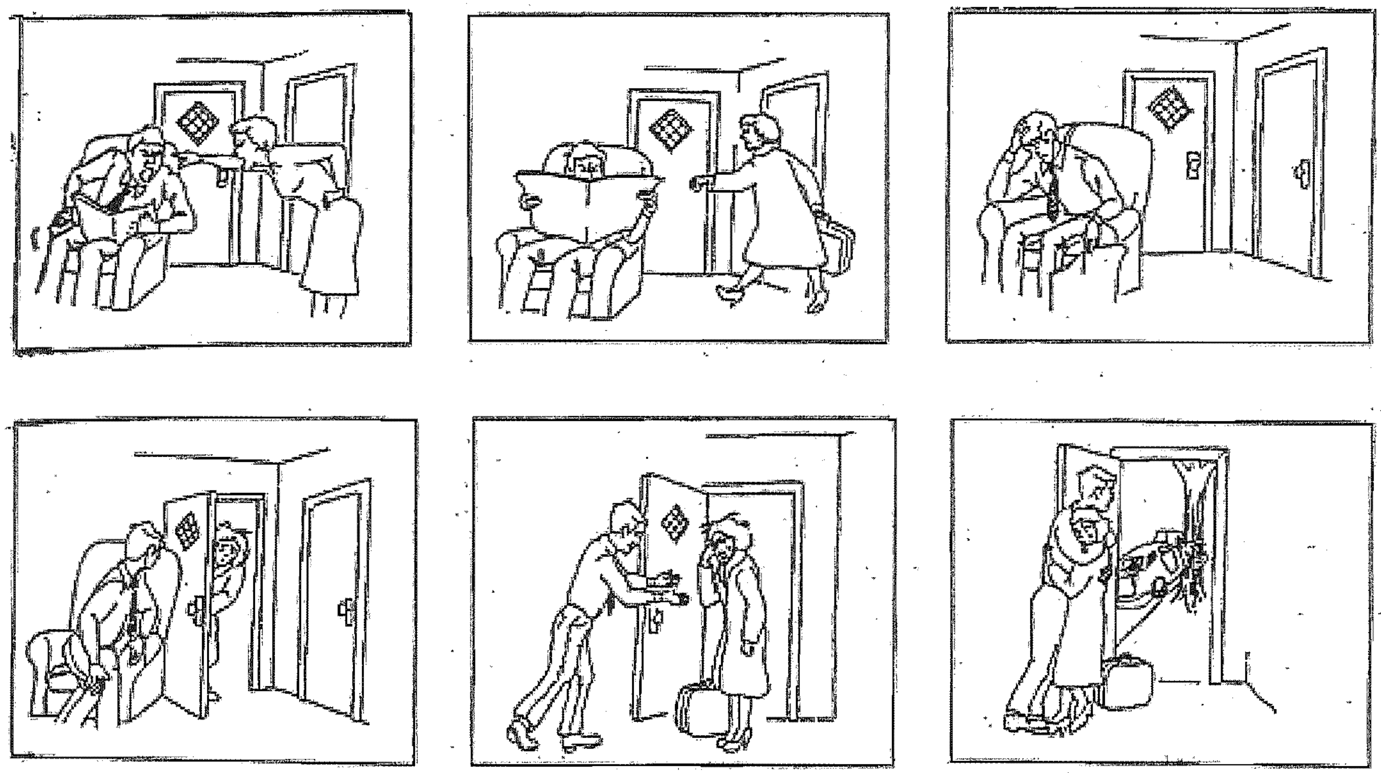
A birthday party scene ruined by a dog[1].



[1] From "Test- retest stability of measures of connected speech in aphasia" by R.H. Brookshire and L.E. Nicholas, 1994, Clinical Aphasiology, 22, p. 121. Copyright 1994 by R.H. Brookshire and L.E. Nicholas. Reprinted without permission because of the inability to locate the authors.

Picture 4

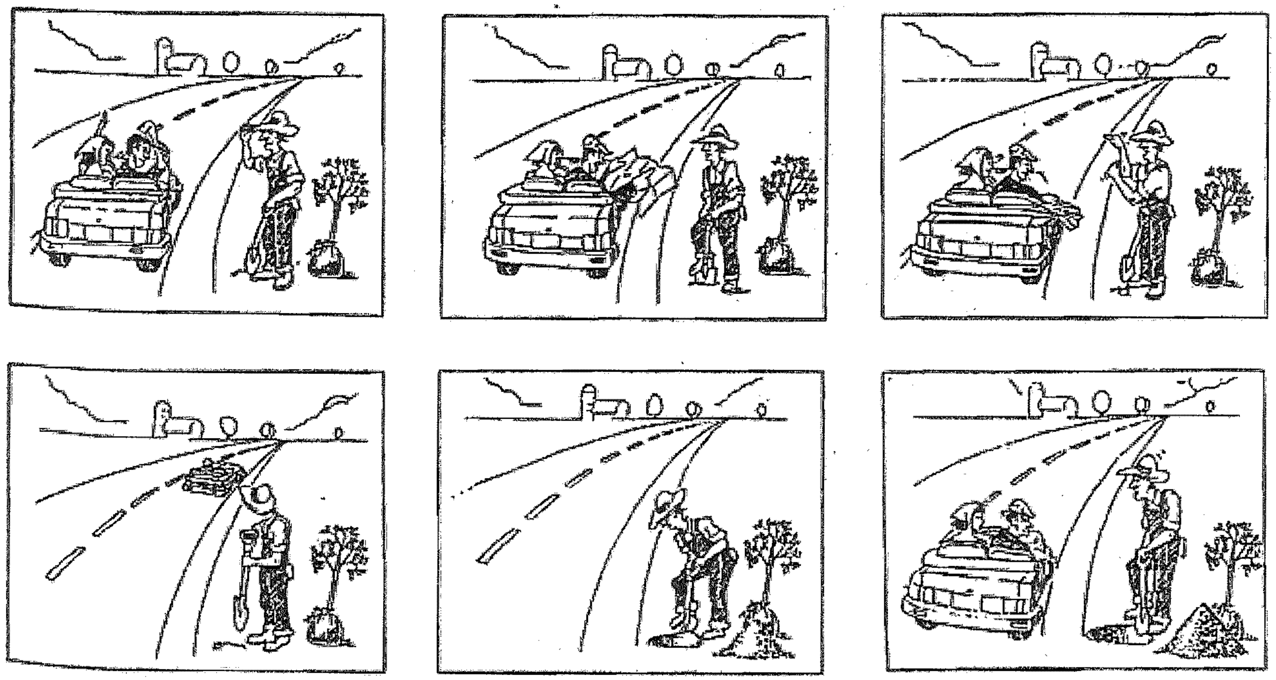
A scene of an argument between a husband and a wife[1].



[1] From "Test- retest stability of measures of connected speech in aphasia" by R.H. Brookshire and L.E. Nicholas, 1994, Clinical Aphasiology, 22, p. 122. Copyright 1994 by R.H. Brookshire and L.E. Nicholas. Reprinted without permission because of the inability to locate the authors.

Picture 5

A scene of a couple finding directions[1].



[1] From "Test- retest stability of measures of connected speech in aphasia" by R.H. Brookshire and L.E. Nicholas, 1994, Clinical Aphasiology, 22, p. 122. Copyright 1994 by R.H. Brookshire and L.E. Nicholas. Reprinted without permission because of the inability to locate the authors.

Appendix F

An example of sample analysis and LARSP transcripts

This appendix consists of:

a) LARSP profile of P1 sample 4 (i.e., sample after the sentence module in Study 1) followed by a detailed analysis of utterances produced by P1.

b) Transcripts of spontaneous speech samples obtained for P1, P2 and P5 in Study 1. Four samples for each participant were obtained.

c) Detailed scores of participants P1-P6 for LARSP variables in Study 1

d) Detailed scores of the four participants for LARSP variables in Study 1A.

```
                              LARSP Profile

Filename:  P1 (Sample post-sentence)
  Age:
  Date:
  Type:
Tabulation Method:  Standard
Range of Utterances:  All
Error Set:  Language of Aphasia

A  UNANALYZED:    Unintelligible 1    Symbolic Noise ·    Deviant ·
   PROBLEMATIC:   Incomplete ·        Ambiguous ·         Stereotypes ·

B  RESPONSES     |            NORMAL RESPONSE              | ABNORMAL    |
                 |-----------Major------------|            |             |
 TOTALS  Repet-  |  Elliptical     Red-       |            | Struc-      | Prob-
         itions  |  1    2    3+   uced  Full |   Minor    | tural   Ý   | lems
  4  Quest       |                  3     1   |            |             |
  5  Other       |                  1     2   |     2      |             |
C 31 Spont       |  3              15     9   |     4      |

I 0;9-1;6  II 1;6-2;0  III 2;0-2;6  IV 2;6-3;0  V 3;0-3;6  VI 3;6-4;6  VII 4;6+

 M I N O R     Responses 3     Vocatives ·     Other 3     Problems ·

        | C O M M  |Q U E S T | S T A T E M E N T |
        | 'V' ·    | 'Q' ·    | 'V' 5    'N' 8       Other ·     Problems ·

  CONN  |                  CLAUSE                  |     PHRASE         | WORD
        | VX ·     | QX ·     | SV 3     AX 2      | DN ·       VV 2    | -ing 5
        |          |          | SO 1     VO 3      | AdjN ·     VPart 4 |
        |          |          | SC 3     VC ·      | NN 8       IntX ·  | pl 3
        |          |          | Neg X ·  Other ·   | PrN 1      Other 2 |
        | X+S:NP 4   X+V:VP 5   X+C:NP 1   X+O:NP 1   X+A:AP 1         | -ed ·
        |                                                              | reg ·
        |                                                              | irr ·
        | VXY ·    | QXY 1    | SVC 1    VCA ·     | DAdjN ·    Cop 1   |
        |          |          | SVO 2    VOA ·     | AdjAdjN ·  Aux-M · | -en 1
        | Let XY · | VS(X) 2  | SVA 1    VOdOi ·   | PrDN ·     Aux-O 2 |
        | Do XY ·  |          | NegXY ·  Other ·   | Pron-P 3   Other · | 3s  3
        |          |          |                    | Pron-O 1           | reg ·
        | XY+S:NP 1  XY+V:VP 2  XY+C:NP ·  XY+O:NP ·  XY+A:AP 2        | irr  3
        |                                                              | gen 6
        | +S ·     | QVS ·    | SVOA 1   AAXY ·    | NPPrNP ·   NegV ·  |
        |          | QXY+ ·   | SVCA ·   Other ·   | PrDAdjN ·  NegX ·  | n't ·
        | VXY+ ·   | VS(X+) · | SVOdOi ·           | cX ·       2 Aux · |
        |          | tag ·    | SVOC ·             | XcX ·      Other · | 'cop ·
 and 3  | Coord ·  | Coord ·  | Coord-1 1  -1+ ·   | Postmod Phr-1+ ·   | 'aux ·
 c ·    | Other ·  | Other 1  | Sub A-1 1  -1+ ·   |                    |
 s 1    |          |          | Sub S ·            |                    | -est ·
 Other ·|          |          | Sub C ·  Sub O ·   |                    |
        |          |          | Comparative ·      |                    | -er ·
        |          |          | Postmod Cl-1 ·     |                    |
        |          |          | Postmod Cl-1+ ·    |                    | -ly ·
```

(+) Passive ·	Complement-C ·	Initiator ·	Complex VP 2
how ·	what ·	Coord NP ·	Complement-P

(-) and- ·	ElemÝ 8	Det- ·	Prep- ·	Modal ·	Oth Aux ·	Irr N ·
conn ·	Elem -> ·	DÝ ·	PrÝ 1	AuxÝ 3	Copula 2	Irr V ·
subord ·	Concord 6	D -> ·	P -> ·	Reg N ·	Pronoun ·	Wordf 4
Other ·			Ambiguous ·			

it ·	there ·	A Connectivity ·	Comment Clause ·	Emphatic Order ·

	Complete & Intelligible	Total	LARSPed
P Sentences	43	43	42
P MLU in words	2.33	2.33	2.36
P MLU in morphemes	2.67	2.67	2.71
P MSL (Klee, 1992)	3.88	-----	-----
Spontaneous Sentences	-----	-----	73.8%
Adequate Responses	-----	-----	100.0%
Mean P Sentences/Turn		3.31	
Mean T Sentences/Turn		1.21	
P Sentences/T Sentences		2.53	
T Sentences		17	(4 Question, 5 Other)
T MLU in words		6.59	

	Number	% of Clauses		Number	% of Phrases
Stage I Clause	13	36.1%	Stage I Phrase	64	71.1%
Stage II Clause	12	33.3%	Stage II Phrase	17	18.9%
Stage III Clause	7	19.4%	Stage III Phrase	7	7.8%
Stage IV Clause	1	2.8%	Stage IV Phrase	0	0.0%
Stage V Clause	3	8.3%	Stage V Phrase	0	0.0%
Stage VI Clause	0	0.0%	Stage VI Phrase	2	2.2%
Stage VII Clause	0	0.0%			
Mean Clausal Complexity		2.26	Mean Sent Complexity - Phrase		3.85

Major sentences that are complex	3/ 34	8.8%
Clauses with 2+ expansions	3/ 36	8.3%
Verb phrases expanded	5/ 21	23.8%

Syntactic complexity score (Blake & Quartaro, 1990): 2.12

```
      1
3:    YES.
1 CL  R
2 SC
3 PH
4 WD
5 ER
6 AI
7 T: Other
8 Not Coded

      1     2   3
4:    MAN'S ARM TIP.
1 CL  S         V
2 SC
3 PH  NN    NN  V
4 WD  GN
5 ER            CD
6 AI  FL
7 Spontaneous
8 Not Coded

      1       2   3  4    5   6   7
6:    WOMAN'S ARM IS TIP, AND RUN OVER.
1 CL  S           V       &   V
2 SC
3 PH  NN      NN  AO V        V   PT
4 WD  GN          3S
5 ER                 CD       0E
6 AI  FL
7 T: Other
8 Not Coded

      1
7:    GIRL.
1 CL  'N
2 SC
3 PH  NN
4 WD
5 ER
6 AI  RD
7 Spontaneous
8 Not Coded

      1
8:    YES.
1 CL  MO
2 SC
3 PH
4 WD
5 ER
6 AI
7 Spontaneous
8 Not Coded

      1   2      3
9:    BOY COOKIE JAR.
1 CL  S   O
2 SC
3 PH  NN  NN     NN
4 WD
5 ER  0E
6 AI  RD
7 Spontaneous
8 Not Coded

      1     2     3
10:   WOMAN DROWN OVER.
1 CL  S     V
2 SC
3 PH  NN    V     PT
4 WD
5 ER  0A    CD
6 AI  FL
7 Spontaneous
8 Not Coded
```

larsputl.txt

```
      1
12:   DISHWASHING.
1 CL  'N
2 SC
3 PH  NN
4 WD
5 ER
6 AI  RD
7 T: Question
8 Not Coded

      1  2   3
14:   T: AND HERE?
1 CL
2 SC
3 PH
4 WD
5 ER
6 AI
7 T: Question
8 Not Coded

      1  2    3        4    5    6   7    8
9       A
16:   T: YEAH ALRIGHT VERY GOOD NOW HERE IS
ANOTHER PICTURE.
1 CL

2 SC

3 PH

4 WD

5 ER

6 AI

7 T: Other
8 Not Coded

      1   2    3      4
17:   MAN KICK LADDER OVER.
1 CL  S   V    O      A
2 SC
3 PH  NN  V    NN     AV
4 WD
5 ER      CD
6 AI  FL
7 Spontaneous
8 Not Coded

      1   2       3   4
18:   ARM REACHED OUT COOKIE.
1 CL  S   V           O
2 SC
3 PH  NN  V       PT  NN
4 WD      EN
5 ER      0A          0P
6 AI  FL
7 Spontaneous
8 Not Coded

      1
19:   LADDER.
1 CL  'N
2 SC
3 PH  NN
4 WD
5 ER
6 AI  RD
7 Spontaneous
8 Not Coded

      1
21:   COOKIE.
1 CL  'N
2 SC
```

```
3 PH   NN
4 WD
5 ER
6 AI   RD
7 T: Question
8 Not Coded

      1  2  3
24:   T: OK HERE?
1 CL  R
2 SC
3 PH
4 WD
5 ER
6 AI
7 T: Question
8 Not Coded

      1 2    3
25:   A FIRE ENGINE.
1 CL    'N
2 SC
3 PH  D NN   NN
4 WD
5 ER
6 AI  EL
7 Spontaneous
8 Not Coded

      1  2    3  4   5    6       7    8
→     9   A   B    C  D
26:   T: HERE IS THE NEXT PICTURE LOOK
→EVERYWHERE AND SEE WHAT IS HAPPENING?
1 CL
→
2 SC
→
3 PH
→
4 WD
→
5 ER
→
6 AI
→
7 Spontaneous
8 Not Coded

      1  2  3   4    5  6    7   8 9
27:   T: DO YOU WANT TO STOP FOR A MINUTE?
1 CL
2 SC
3 PH
4 WD
5 ER
6 AI
7 Spontaneous
8 Not Coded

      1
28:   NO.
1 CL  R
2 SC
3 PH
4 WD
5 ER
6 AI
7 Spontaneous
8 Not Coded

      1  2
30:   DO YOU.
1 CL  V  S
2 SC
3 PH  V  PP
4 WD
5 ER     OE
6 AI  RD
```



```
7 T: Question
8 Not Coded

      1
31:   NO.
1 CL  MO
2 SC
3 PH
4 WD
5 ER
6 AI  FL
7 Spontaneous
8 Not Coded

      1  2
32:   T: YEAH.
1 CL
2 SC
3 PH
4 WD
5 ER
6 AI
7 Spontaneous
8 Not Coded

      1
33:   SWEEP.
1 CL  'V
2 SC
3 PH  V
4 WD
5 ER
6 AI  RD
7 Spontaneous
8 Not Coded

      1   2         3    4
35:   BOY ARRIVING WITH OTHERS.
1 CL  S   V         A
2 SC
3 PH  NN  V         PR   PO
4 WD          NG
5 ER          OA
6 AI  FL
7 T: Other
8 Not Coded

      1  2    3        4
37:   T: WHAT HAPPENED HERE?
1 CL  R
2 SC
3 PH
4 WD
5 ER
6 AI
7 T: Question
8 Not Coded

      1
38:   YES.
1 CL  MO
2 SC
3 PH
4 WD
5 ER
6 AI
7 Spontaneous
8 Not Coded

      1
39:   PUSH.
1 CL  'V
2 SC
3 PH  V
4 WD
5 ER
6 AI  RD
7 Spontaneous
```

```
8 Not Coded

      1    2
40:   PUSH LIE.
1 CL  'V
2 SC
3 PH  V    V
4 WD
5 ER  OE
6 AI  RD
7 Spontaneous
8 Not Coded

      1   2   3
41:   LIE DOG HOME.
1 CL  V   S   A
2 SC
3 PH  V   NN  AV
4 WD
5 ER      OE
6 AI  FL
7 T: Question
8 Not Coded

      1
43:   DOG.
1 CL  'N
2 SC
3 PH  NN
4 WD
5 ER
6 AI  RD
7 T: Other
8 Not Coded

      1   2  3
44:   BOY IN TEARS.
1 CL  S   C
2 SC
3 PH  NN  PR NN
4 WD         PL
5 ER  C-
6 AI  RD
7 Spontaneous
8 Not Coded

      1  2   3
45:   T: YES OKAY.
1 CL
2 SC
3 PH
4 WD
5 ER  OE
6 AI  EL
7 Spontaneous
8 Not Coded

      1   2  3
47:   BOY IS MAN.
1 CL  S   V  C
2 SC
3 PH  NN  CP NN
4 WD      3S
5 ER         WF
6 AI  RD
7 Spontaneous
8 Not Coded

      1   2      3  4
48:   AND ARMING TO TRASH.
1 CL  &   V      A
2 SC             V
3 PH      V      V
4 WD      NG
5 ER
6 AI  FL
7 Spontaneous
8 Not Coded
```

```
      1  2    3    4  5    6  7     8
9     A    B    C    D  E          F
49:   T: YOU HAVE TO LOOK AT EVERY PICTURE
CAN YOU TELL WHAT IS HAPPENING HERE?
1 CL  6
  T:
?
3 -
4 ..
5
6
7 8 Not Coded

      1
50:   YES.
1 CL  R
2 SC
3 PH
4 WD
5 ER
6 AI
7 T: Other
8 Not Coded

      1   2   3
51:   GO, GET IT.
1 CL  V
2 SC  ~   V   O
3 PH  V   V   PP
4 WD
5 ER
6 AI  FL
7 Spontaneous
8 Not Coded

      1
52:   MATCHSH.
1 CL  UT
2 SC
3 PH
4 WD
5 ER
6 AI
7 Spontaneous
8 Not Coded

      1  2     3    4  5
53:   T: SORRY WHAT IS THAT?
1 CL
2 SC
3 PH
4 WD
5 ER
6 AI
D OG
7 8 Not Coded

      1
54:   BASH.
1 CL  'V
2 SC
3 PH  V
4 WD
5 ER
6 AI  RD
7 Spontaneous
8 Not Coded

      1  2   3  4    5   6        7       8
55:   T: NOW WE HAVE GOT ANOTHER PICTURE
```

```
➔HERE.
 1 CL
➔
 2 SC
➔
 3 PH
 T
 4 WD
 H
 5 ER

 6 AI
 M   AN
 7 8 Not Coded

        1   2     3  4  5
 56:    HOW LONG IT TO GET.
 1 CL   Q         S  A
 2 SC                >  V
 3 PH             PP V
 4 WD
 5 ER             0E
 6 AI   RD
 7 Spontaneous
 8 Not Coded

        1    2   3
 57:    TAKE GET ZUKIK.
 1 CL   V        O
 2 SC
 3 PH   V    V   NN
 4 WD
 5 ER            WF
 6 AI   FL
 7 Spontaneous
 8 Not Coded

        1   2   3
 58:    MAN ARM SQUARET.
 1 CL   S       C
 2 SC
 3 PH   V   NN  NN
 4 WD
 5 ER   CD  C-  WF
 6 AI   RD
 7 Spontaneous
 8 Not Coded

        1     2   3
 59:    MAN'S ARM SWART.
 1 CL   S         C
 2 SC
 3 PH   NN    NN  NN
 4 WD   GN
 5 ER             WF
 6 AI   RD
 7 Spontaneous
 8 Not Coded

        1  2  3
 60:    T: OK OKAY.
 1 CL
 2 SC
 3 PH
 4 WD
 5 ER
 6 AI
 7 8 Not Coded
```

P1 Sample 1 (Baseline)

hhh.
(patient laughs) .
cookie jar.
(uh) wud (uh) clother clothe.
= unintelligible.
yes.
yes, wugi (uh) .
= unintelligible.
t: what is happening here?
yes, (uh) puffet.
one (uh) .
[laughs after 'yes']
there are ^
t: ok, anything else happening?
t: [shows the next picture].
(uh) cat has climbed trees (uh) .
a dog (uh) yes^
t: yeah.
yes, (uh) two hands.
a trike.
(uh) dog.
yes, ladder.
a ryenjet.
t: ok what about this one?
dog eats cake (umm) .
(uh) (uh) two boy.
(uh) two girls.
a boy and girl.
(uh) has helping a spillet.
yes.
t: ok here I have got a sequence of pictures like this, ok?
t: can you tell me what is happening in the picture?
(hmm) a telling him off.
(uh) (a) a tree.
yes, a^
yes.
t: yeah.
yes, (a yes) a trees (yes) .
t: ok, this one.
=[long pause]
=[banging her hand on the desk to get the word].
yes.

P1 Sample 2 (after word module)

t: you have to look at the picture and tell me what is happening.
t: now you can say the words, you can say them.
yeah, (yeah) .
t: you can say them.
(uh) tricycle and these glasses.
t: yeah.
gard mowing (se) grass.
and bird singing the.
pik shum.
t: yes.
[makes a sound with her hand]
ladder.
t: yes, and what are these men doing here?
carrying a ladder.
t: yes, and what is this girl doing here?
(uh) (uh) army track suit carrying a cat.
t: ok anything else?
fire engine.
t: I've got another picture here look, carefully at the picture and see, what is happening and tell me.
(hh) (patient laughs) .
(uh) why^
(uh) let^
t: yeah, look, everywhere, here and here and here and here.
yes, (uh) (jig) jigsaw (umm) .
doing a XXX.
(uh) (man over) (w), man (uh) ^
(man [whispered] man), man over woman.
no!
t: okay, what else is happening?
(uh) cobdoy's (uh) parcel.
woman (wonman) with broom?
t: yes, anything else? here?
yes, cake.
pordoil (patient laughs) .
=pordoil unintelligible.
t: yes.
woman has cut.
(l) (lay) lay a man.
t: yes, anything else?
yes.
t: Ok here I am going to show you a sequence of pictures.
t: you have to look, at all the pictures carefully and tell me what is happening.
[long pause].
a (l) lady telling man off.
lady leave the man.
t: yes.
yes, was misery first (uh) .

sbleat (uh) .
=unintelligible.
man come back.
and man make(ud) .
she^
[long pause].
she (uh) come.
man's come back and huggy dear.
t: yeah.
umm.
[noise] man (uh) ^
[patient coughs].
man (pause) instructions.
a man^
(umm) yeah.
sukrana guther.
=unintelligible.
(uh), could gra.
=unintelligible
t: yeah.
(uh) man.
a boy^
boy call his (uh) (a da) .
sink (uh) running over.
(da aa), drain run over, yes.
t: and what is this lady doing here?
drying a plate.
t: yes, anything else?
no.
t: okay.

P1 Sample 3 (after affix module)

t: alright, I am going to show you some pictures.
t: you have to look at the picture and tell me what is happening in the picture.
(uh) firemen>
t: yes.
yes, (yes) .
=pause.
yes, ladder (uh) >
(tob) (gold it) hold it >
(heavy breathing) .
dog.
talk.
man.
birds XXXX a tree.
=unintelligible word
talk.
=(trying to say)
t: why are they bringing the ladder?
yes, a (mid) girl couldn't listen.
(uh) ladder.
(uh, uh) .
t: okay?
t: you want to say anything else?
t: this is the second picture, again you have to look see what is happening and tell me.
dog ate the bone.
dog bone (bone) .
kid upset.
dog (uh) up his head.
(ooh) dog.
he (uh) room (uh) >
t: okay, you have to look at the sequence and tell me what is happening.
t: here, start from here.
do watch.
do what.
do>
(pause) oh,yes.
do watch it you do,(uh) >
do.
=(unable to get the word out, taps her thigh in frustration).
do what(uh) >
frogid.
=(taps again) (unintelligible word, frogid)
t: alright, look at another sequence.
(long pause) no.
t: ok.
t: (therapist showed another picture but subject unable to say any more).

P1 Sample 4 (after sentence module)

t: this is the first picture, this is a cookie theft picture.
t: here you have to look at the picture, and think what is happening, and then you try to say it.
yes.
man's (uh) arm tip.
t: yes.
(uh) (man's) woman's arm is tip, and run over.
girl.
yes.
boy (uh) cookie jar.
(man) woman drown over.
t: and here?
dishwashing.
washing dishes.
t: and here?
man's arm is taking out cookies.
t: yeah, alright, very good Now,here is another picture.
man kick ladder over.
arm reached out cookie.
ladder.
man's ladder.
cookie.
man's ladder.
cookie.
(man's ladder, cookie) .
(man's ladder, cookie) .
=[man's ladder, cookie, perseveration].
t: ok, here?
a fire engine.
t: here is the next picture, look everywhere and see what is happening?
t: DO you want to stop for a minute?
no.
do (uh) .
do you.
no.
t: yeah.
sweep.
man.
boy arriving with others.
sit and partying.
t: what happened here?
yes.
push.
push lie.
lie dog home.
push along.
dog.
boy in tears.

t: yes, okay.
t: now I will show you a sequence here, a sequence of pictures.
(uh) .
boy is man.
and arming to trash.
t: you have to look at every picture, can you tell what is happening here?
yes.
go,get it.
matchsh.
=unintelligible.
t: sorry, what is that?
bash.
[wants to say 'trash'].
t: now we have got another picture here.
how long it to get.
take get zukik.
=zukik unintelligible.
(arm) man arm squaret.
=squaret unintelligible.
man's arm swart.
=swart unintelligible.
t: ok, okay.

P2 Sample 1 (Baseline)

t: ok, can you tell what were you doing before you became sick?
sick?
t: before you had a stroke.
yes.
t: what were you doing?
t: were you working?
(no), no but (here beside), (uh), yes.
(uh, umm, yeah), but (uh) .
t: woudl you like to tell me what is happening in this picture?
here, (uh), yes, but here beside, (here beside) .
(oh), yes.
t: yeah.
here beside, (oh) .
t: yeah, look here and look here what is happening.
yes.
but here beside ooh.
fall over, yes.
fall over and here beside (ooh) .
t: something else you can see.
yes, but>
(uh), yes, but here beside, umm.
one two three four, unhun.
yes, cookies, and here beside, (ooh) .
t: date one0th april, preintervention assessment.
but, yes, but here beside me.
here beside me, and (here beside) .
and here beside.
(oh), over boo (boo) .
here beside, and here beside.
shhh yes, and yes, but here beside.
t: and here.
yes, but here beside me.
t: what about this one?
yes, and here beside me.
here beside here.
bird, (uh), big bird.
bird and people.
and here beside, people and>
yes.
but here beside me.
and a boon (for broom) and here beside, people.
and here beside, yes, cake.
but here beside me and here beside me.
yes, cake and here beside me.
table, no!
here beside, tray.
here beside me, yes.
and here and here.

t (t) >
here beside me, here beside.
t: would you like to say something else?
no.
t: ok.
(you can not write on that one, I will give you this one) .
t: chair.
yes.
(uh) .
beside, (ooh) .
here beside.
(acts out) .
here beside (uh) ?
(oh), here beside me.
t: yes, yes.
t: ok.
but here beside, here beside.
and (oh), here beside.
yes, and bye.
bye?
t: yeah.
bye and here beside me.
t: (uh).
here beside.
yes.
here beside, (here beside) .
but dirt, yes, dirt.
dirt?
um.
t: alright.

P2 Sample 2 (after word module)

and here beside.
yes, hat and.
here beside.
(oh) but pull over the.
here beside.
and here beside.
yes.
t: you want to tell me what are these?
cully?
cully, no!
t: and who is this?
t: who is this and who is this?
yes, Dad and a mum.
but here beside(oh!) .
here beside (oh!) .
t: what is this?
yes, what is?
yes.
t: ok this is the other picture.
yes.
but (um) .
but (um) .
a fire engine.
here beside (shhh) .
(hat) no, hat.
here beside.
hat and.
here beside.
(uh), no.
but here beside.
here beside.
and here beside (pshh) .
(bike) yes, a bike.
t: yes.
(dog) a dog.
and (um) .
t: yes.
tree, no.
trees and oooh.
=acting of dog making sound.
and here beside.
here beside (um) .
t: now we will go to the next picture.
t: what is happening in this picture?
lamp.
t: um.
lamp.
(oh) lamp!

t: yes.
a lamp.
(um) here beside.
t: yes.
here beside and here beside.
but doll, (dlog) dog.
and here beside.
(um), no.
(mum) a mum.
and but here beside.
(um) mum and dad, dad and.
here beside.
(oh) ! yes.
yes.
t: and what about these people here.
yes, a mum and a dad, no.
dad, (dad,) (oh) !
but here beside.
here and here.
one two.
t: good.
t: here is a sequence of pictures and here you have to tell me what is happening in every picture.
yes, (um) .
here beside.
here beside.
and boy, no.
boy.
and.
but here beside.
but here beside.
dirt.
here beside.
t: okay.
yes.
here beside.
but here beside.
then.
here beside.
(girl) girl?
and (oh) .
t: (um).
dad.
t: yeah.
here beside and here beside.
girl and dad.
dad and girl.
and (oh) .
t: yes?
t: very good.

t: there is this one this is another sequence.
here beside.
hat?
hat.
here beside.
and here beside.
(oh) .
here beside.
hat and >
here and here.
t: alright.

P2 Sample 3 (after affix module)

t: here is a picture and you have to tell me what is happening in the picture.
yes.
t: take your time to say the words.
here besi, (oh) .
(um) (cat) a cat, fall.
fall over a bike.
t: yes.
here beside.
(um) but here beside.
but here beside.
no.
here, here.
(um), no.
here beside (pshh) .
here beside me.
(ubu ubu ubu) .
=unintelligible.
and here beside me (ooh ooh) .
(fire engine) so fireengine and ladder.
yes, ladder.
here beside.
fire engine and ladder.
t: here is the next picture.
(oh), yes.
(um) (patient laughs) .
here, here beside.
here and here.
here beside but>
oh! yes.
here beside.
but here beside.
(oh) (chairs) and chairs.
here beside me.
(um) .
candle, yes.
five six.
no.
men, no.
lady (lady) .
men.
here beside and here beside.
lady and men.
yes, (lady) and lady.
but here beside.
t: alright.
t: here is a sequence of pictures.
yeah.
t: and you have to look and say what is happening in every picture.

but here beside.
lady, no.
man.
but here beside.
(um) here beside.
girl, no.
here beside.
man and girl.
man and girl.
here beside.
(acts snoring) .
here beside and here beside.
and (acts out) .
t: here is another sequence.
ok hat and.
here beside.
here beside.
(oh) yes.
but here beside me.
yes.
but here beside and here beside.
but here beside.
=(unintelligible word) .
here beside.
garden, (garden) .
and (um) garden.
(oh!) here beside and here beside.
yes.
t: right.
t: this is cookie theft picture from boston diagnostic.
but here beside me.
girls and.
here beside.
but here beside (ooh, ooh) .
cookies (cookies) .
(oh) here beside.
here beside.
a man and a girl.
man, no girls.
tea towel.
oh, tea towel!
here beside (oh) .
t: what is she doing with the tea towel?
(clos) .
=unintelligible
tea towels?
yes.
and here beside.
t: alright.
t: what is the next one?

t: what else is happening?
a girls and.
t: alright.

P2 Sample 4 (after sentence module)

t: ok, this is a picture and you have to look at what is happening in the picture.
t: and tell me what is happening.
cookies.
t: yes.
yes.
but here beside, here beside.
here beside (ooh) .
t: try to say what it is.
what it is.
uh) here beside.
no.
t: what is happening here?
(uh) no.
here beside.
t: ok.
yes.
but here beside, here (oh!!) .
oh!!
here.
here.
but (drop), yes, dropped.
dropped.
yeah, cooking.
t: alright.
t: we go to the next picture.
yes.
cat and.
but here beside.
here (uh) .
ladder and.
but here beside.
nana.
here beside boo (boo boo) .
(man) yes, man.
here beside.
a ladder (wooo) .
ladder, lad and a fire engine.
yes, a fireeng(ine) .
a fireengine and huh.
and here beside and here beside.
t: I will show you another picture here You have to tell me what is happening in the picture.
here beside.
lamp.
lamp.
here beside (ururur) .
dog, no.
here beside (urrr) .

=unintelligible word
phishh.
ladder, no.
here beside.
and a ladder.
and here.
and here.
(um) chey.
=unintelligible word
chair, (chair) .
here beside.
one two three four.
no.
ladder, no.
(um) .
t: what happened here?
here beside.
fire>
here beside (ukhch) .
t: then I will show you another picture.
t: you have to look at every picture.
yes, (yes) .
man and woman.
man and girl.
here beside.
oh! here beside.
a man and a woman.
here beside.
(uh) .
here beside.
and here beside (wooh) .
t: ok, this is the next picture.
hat.
yes, (um) .
but here beside.
here.
here beside.
yes, dad and girl, no.
dad, yes, dad.
here beside.
fire, no.
but>
here.
t: it is okay, you finish this.
t: okay.
yes.
(um) .
t: alright.
yes.
dad and>

dad and>
yes.

P5 Sample 1 (Baseline)

t: tell me what is happening.
yes, alright.
(you can) someone is girl (oh dear) (the (uh) uh) .
the man is (in the) (uh) on the buhuh.
I can >
(uh) he has gone (to the people) to the (what you call) (uh) fireman.
the man off the tree because he is very (be) (uh) there and he's got the dog.
=reformulation of 'be' to 'there'
what's the wee girl>
she is >
she is fright over there, I think.
=comment clause moved to the end.
and the girl over (is) (uh) (is), (I think), is I think.
(uh) that's all, I don't know.
yes.
t: here again you have to look at what is happening in the picture and you have to tell me.
who does that one?
[patient laughs]
I like that one.
dog is (uh) >
the dog is down there because (he is getting) he is bite, I know.
=comment clause 'I know' moved to the end of utterance
everyone is being because the boy has got the cake, (cake) and mark is up and.
(boys have their) mothers get to the boys too because they are naughty, yes.
[patient laughs]
yes, because yes >
what else, anything?
t: here this is a sequence of pictures, like this, ok?
yes, ok.
t: and you have to look at every picture and tell me what is happening.
dad has got the I don't know.
=comment clause 'I don't know' moved to the end.
she is going at him.
she has got a >
she is getting that first.
get him off and took the first to.
I don't know what is (happening?) .
she was got her (I'm going home) I'm going home.
yeah, and then he's got to do and but>
they are better now.
she is better and she has got to >
so she was going that door.
she is back again, she is, yeah.
t: ok, there is another one.
I don't know about this one.
he is going to >
the man has got a bike to after one to (uh) oh dear.

he got him, thank you very much.
and he is going away, not too far, in there, that way.
man I don't know.
what better day, I don't know.
that may be very good, I can't.
he's going away (in the) back to the place where he was before.
I don't know what he is.
t: ok.

P5 Sample 2 (after word module)

t: this is a picture, ok, you have to (see) look in the picture what is happening.
t: and try to say what you see in the picture, what is happening.
the geen the (uh uh) .
I can't say it, (the, the) .
the mother is putting water,is working over there, (she is) well she is.
the children are being naughty (at the) (at the) trying to take cookies out of the jar.
the place is making a mess all over the floor, that's all.
t: thank you here is another picture.
t: here you have to look and say again.
the children are on the ^
(the chicken, the bird is or may be it is cat), it is cat.
it's come to get (the) the children, (children) .
it's lovely but the firemen are coming to let (off) off the cat.
the dog is saying to the chain and wants to go to the cat.
that one's hiding, he is getting away from the cat.
everything, (that) 's alright.
t: ok, here's another picture.
yes.
t: you have to look at what is happening in the picture and tell it.
i'm not quite yes at the^
(he) the dog has been bad (at the) at the, eating the^
(the dog) (at the), (cat is), he is hiding away from the^
their mother gets a ^
he (took the) get his bag (bad) he has been at the cats.
the (cats) dog has been to the (sun) sunday.
the mother was imisan, (the chop) .
naughty cat to get the dog.
[unintelligible word 'imisan']
I know you got to do.
t: alright, here there is a sequence of pictures.
t: and you have to look at every picture and tell me what is happening.
he is growling at something, he is (me) cross about that.
she is having a look at his^
she is having (a him) take him away because he's got his.
he's had a laugh and then he is worrying about it.
then, she (she) comes back (and with her) and she is very ^
[knock on the door]
t: would you like to continue where you were.
yes, we had it all.
then she come back.
she came back and was sorry and she is giving a hug.
and she is good (she is good) .
t: very good ok, here is the last picture.
t: again this is a sequence of pictures, you look at every picture and see.
I can not what they're doing.
she is ^
(uh), yes, (that one) what he is doing?
I can't that way, I don't know.

he is going alright (and comes) he is comes back (and comes back), yes.
[says something unintelligible]
I can't.
that one makes me mad it is silly.
t: ok.
it doesn't.
he's gone and he is back (and he is back) .
I don't know.
t: alright thank you.
it's silly.

P5 Sample 3 (after affix module)

t: I want you to look at the picture here and tell me what is happening in the picture.
oh dear!
he want to all his>
the girl's (come off the) clean the>
she is (off the on gone) off >
oh dear, I am silly.
t: it is alright.
she is (got the) having the xxx.
[unintelligible word].
the water is coming (off the) off the work.
and he is trying to do it.
this is done and it is going (to do all the place) to do all the place.
and then the boys are having a fight (about) of the.
she wouldn't off there (off there) fighting at the jar.
and then, the fall the off and the.
oh dear.
she's taken.
she is trying to get the jar from the boy and pulls on the floor, on the front.
yes.
get them off.
children have done that to get on their>
the children awful.
that's all.
t: thank you.
t: now, I am going to show you another picture.
yes.
t: here.
yes.
oh!!
t: you have to tell me what is happening in the picture.
time to get the children out of the (the) tree.
they (and) got stuck and has got to.
the dog's trying to and yes.
yes, and the child.
once the children want the bills.
and (child) he said get it (off and) off from the tree.
of the (the) children.
alright, silly me.
t: don't worry, take your time.
the dog after the man.
(the postman, no) the fire engine trying to get the man off the tree.
=reformulation
~and the wee girl wants other things on there.
t: alright.
t: here is another picture.
t: again you have to tell me what is happening in the picture.
where is he? he is in there.
the dog has been at the cake.

the cake has been at the>
and come home, hiding under the chair.
the mother is going to XX her and she is cross and going to get her fitting.
=[unintelligible].
and the other children have come to say, it happens.
the garden.
no, he is going to.
I think he is.
is it part of C on there?
I don't know.
he is going to get a>
he is got the.
no, it is alright.
t: here is another picture.
t: this is a sequence of pictures and you have to tell me what is happening in every picture.
he is, oh dear.
he is dropping.
she is getting bad.
she is (uh) (she)>
they had a fight about something.
and she is going to (going to) have own way.
and the fight about her>
the, no, I can't>
she is going to take her home to her and (she is) he is doing this.
he is not happy about it.
she is going to come home and he is happy about it.
I can't see that one.
oh no, he is got the.
he is happy.
they have come home together, yes.
t: alright, here.
t: do you want your glasses?
it won't work.
no, they don't help me.
I can't see anything.
she is (going to a) going away.
she is going to be.
you can.
alright.
you are going to do that.
he is going to say where is he going?
he is going away.
and she is going to>
he is gone away.
what did he>
and he did not put it in there.
and has not done it yet.
I can't know that.
why he is>

okay, I will.
I have got this man and I.
can't that one.
doesn't do it.
t: ok.
it is funny, this one.
it does not put away.
it is silly.
t: ok.
t: thank you.

P5 Sample 4 (after sentence module)

t: here is a picture, and you have to tell me what is happening in the picture.
woman has got the two other >
the bottle is bolting off back to the it won't go.
the boys were having (having have the the) the party.
and therefore fourteen (have all other all the) having the.
of the Joe is having a party and having about the.
all the things are XX.
that's all.
t: another picture.
the fireman to get the>
it was floating in the, serving on the>
the children have got is it kitten it is a kitten.
trying to get off the branch of the tree and who (is got) is got.
waiting him trying to get him off down.
he's had>
and that's that one.
he wants a cat off the.
the (cat was the) cat was go.
he wants it.
that's it.
t: here is the next one.
she is there oh dear!
she is naughty.
the boy has the XX.
the boy is going to get this much the back of the carton.
I like this one.
it is all being but can't do his he can>
alright.
t: ok, here there is a sequence of pictures and I want you to look at every picture.
t: and tell me what is happening.
they are the father and father having a XX>
yes, something of the>
she is mad and gone.
she is going to weigh him with her mother and the boys.
that makes him pleased.
the good one.
I wonder what (was the) was wrong.
he came back again, that is the one.
that is easy.
t: here is another one.
getting the boys in the car.
going to the yes.
he didn't have.
I can't that one.
he's back again.
he's gone to check the way from the way and way away and then he is going to.
I don't know that one.
t: ok.

I can't see that one.
it is silly.
t: just say what you think.
yes.
I can't, he is the.
he can't relate why the people at the they've (got the) made the XX >
don't know.
why these people made the (the) faces .
I don't know anything.
t: alright, thank you.

Table F.1 Mean and range values of spontaneous speech measures for normal speakers and from four samples of P1 obtained during baseline, after module1 (post-word), module 2 (post-affix) and module 3 (post-sentence).

Measures	Mean	Range	Baseline	Post-word	Post-affix	Post-sentence
Utterances						
Total utterances	31.78	19-54	25	38	26	39
Spontaneous utterances	26.42	11-52	16	17	19	24
Minor utterances	1.57	0-6	3	3	3	6
Major utterances	29.14	17-46	17	28	22	30
Unanalyzed utterances	0.00		2	3	1	1
Problematic utterances	0.07	0-1	3	3	0	0
MLU in words	10.86	7.57-14.21	2.24	2.58	1.92	2.21
Verb phrases expanded	18.85	6-40	2	3	2	4
Total verb phrases	51.07	29-86	4	18	9	19
Syntactic complexity score	5.25	4.5-6.6	1.27	2.04	1.93	2.14
Clausal complexity	9.91	7.33-15.83	1.41	2.14	1.64	2.17
Phrase complexity	15.79	12.79-18.39	3.18	3.71	3.05	3.90
Syntactic Stages						
Stage I clause	0.14	0-1	13	8	11	15
Stage II clause	11.07	5-20	1	10	8	9
Stage III clause	23.42	13-36	3	9	3	6
Stage IV clause	15.35	3-30	0	0	0	1
Stage V clause	21.92	9-47	0	1	0	2
Stage VI clause	2.07	0-6	0	0	0	0
Stage VII clause	3.21	0-8	0	0	0	0
No. of connectives	23.85	13-44	0	4	0	3
Lexical						
Nouns – Types	47.07	31-75	17	25	11	17
Nouns – Tokens	66.85	38-126	20	37	17	35
Verbs – Types	35.85	23-62	3	15	6	19
Verbs – Tokens	51.21	28-90	3	17	12	24
Verb valency						
Intransitive types	17.28	6-36	0	3	3	15
Intransitive tokens	23.92	8-48	0	3	9	20
Transitive verb types	19.00	12-28	3	11	3	4
Transitive verb tokens	26.28	15-52	3	14	3	4
Ditransitive types	0.429	0-2	0	0	0	0
Ditransitive tokens	0.857	0-4	0	0	0	0
Inflection						
Present inflection -ing	8.64	2-20	1	8	0	4
Past inflection -ed	1.143	0-4	0	0	0	0
Irregular past	0.929	0-3	0	0	1	0

Table F.2 Mean and range values of spontaneous speech measures for normal speakers and from four samples of P2 obtained during baseline, after module1 (post-word), module 2 (post-affix) and module 3 (post-sentence).

Measures	Mean	Range	Baseline	Post-word	Post-affix	Post-sentence
Utterances						
Total utterances	31.78	19-54	72	84	78	77
Spontaneous utterances	26.42	11-52	25	46	44	41
Minor utterances	1.57	0-6	22	18	15	16
Major utterances	29.14	17-46	13	32	26	28
Unanalyzed utterances	0.00		0	0	0	2
Problematic utterances	0.07	0-1	37	36	37	31
MLU in words	10.86	7.57-14.21	2.48	2.20	2.45	2.13
Verb phrases expanded	18.85	6-40	0	1	0	0
Total verb phrases	51.07	29-86	2	2	2	2
Syntactic complexity score	5.25	4.5-6.6	0.94	1.20	1.16	1.18
Clausal complexity	9.91	7.33-15.83	1.15	0.94	1.03	1.11
Phrase complexity	15.79	12.79-18.39	3.92	3.81	3.83	4.11
Syntactic Stages						
Stage I clause	0.14	0-1	15	30	26	28
Stage II clause	11.07	5-20	0	2	2	0
Stage III clause	23.42	13-36	0	0	0	1
Stage IV clause	15.35	3-30	0	0	0	0
Stage V clause	21.92	9-47	0	0	0	0
0Stage VI clause	2.07	0-6	0	0	0	0
Stage VII clause	3.21	0-8	0	0	0	0
No. of connectives	23.85	13-44	2	2	1	0
Lexical						
Nouns – Types	47.07	31-75	9	15	21	17
Nouns – Tokens	66.85	38-126	15	37	39	33
Verbs – Types	35.85	23-62	1	1	1	2
Verbs – Tokens	51.21	28-90	2	1	2	3
Verb valency						
Intransitive types	17.28	6-36	1	0	1	1
Intransitive tokens	23.92	8-48	2	0	2	1
Transitive verb types	19.00	12-28	0	1	0	1
Transitive verb tokens	26.28	15-52	0	1	0	2
Ditransitive types	0.429	0-2	0	0	0	0
Ditransitive tokens	0.857	0-4	0	0	0	0
Inflection						
Present inflection -ing	8.64	2-20	0	0	0	1
Past inflection -ed	1.143	0-4	0	0	0	1
Irregular past	0.929	0-3	0	0	0	0

Table F.3 Mean and range values of spontaneous speech measures for normal speakers and from four samples of P3 obtained during baseline, after module1 (post-word), module 2 (post-affix) and module 3 (post-sentence).

Measures	Mean	Range	Baseline	Post-word	Post-affix	Post-sentence
Utterances						
Total utterances	31.78	19-54	0	0	8	1
Spontaneous utterances	26.42	11-52	0	0	1	0
Minor utterances	1.57	0-6	0	0	5	0
Major utterances	29.14	17-46	0	0	2	1
Unanalyzed utterances	0.00		0	0	0	0
Problematic utterances	0.07	0-1	0	0	1	0
MLU in words	10.86	7.57-14.21	0	0	1.13	2.00
Verb phrases expanded	18.85	6-40	0	0	0	0
Total verb phrases	51.07	29-86	0	0	0	0
Syntactic complexity score	5.25	4.5-6.6	0	0	0.00	1.00
Clausal complexity	9.91	7.33-15.83	0	0	1.00	1.00
Phrase complexity	15.79	12.79-18.39	0	0	4.00	2.00
Syntactic Stages						
Stage I clause	0.14	0-1	0	0	2	1
Stage II clause	11.07	5-20	0	0	0	0
Stage III clause	23.42	13-36	0	0	0	0
Stage IV clause	15.35	3-30	0	0	0	0
Stage V clause	21.92	9-47	0	0	0	0
Stage VI clause	2.07	0-6	0	0	0	0
Stage VII clause	3.21	0-8	0	0	0	0
No. of connectives	23.85	13-44	0	0	0	0
Lexical						
Nouns – Types	47.07	31-75	0	0	0	0
Nouns – Tokens	66.85	38-126	0	0	0	0
Verbs – Types	35.85	23-62	0	0	0	0
Verbs – Tokens	51.21	28-90	0	0	0	0
Verb valency						
Intransitive types	17.28	6-36	0	0	0	0
Intransitive tokens	23.92	8-48	0	0	0	0
Transitive verb types	19.00	12-28	0	0	0	0
Transitive verb tokens	26.28	15-52	0	0	0	0
Ditransitive types	0.429	0-2	0	0	0	0
Ditransitive tokens	0.857	0-4	0	0	0	0
Inflection						
Present inflection -ing	8.64	2-20	0	0	0	0
Past inflection -ed	1.143	0-4	0	0	0	0
Irregular past	0.929	0-3	0	0	0	0

Table F.4 Mean and range values of spontaneous speech measures for normal speakers and from four samples of P4 obtained during baseline, after module1 (post-word), module 2 (post-affix) and module 3 (post-sentence).

Measures	Mean	Range	Baseline	Post-word	Post-affix	Post-sentence
Utterances						
Total utterances	31.78	19-54	67	47	34	20
Spontaneous utterances	26.42	11-52	49	37	15	13
Minor utterances	1.57	0-6	19	17	7	2
Major utterances	29.14	17-46	36	24	14	14
Unanalyzed utterances	0.00		12	5	12	4
Problematic utterances	0.07	0-1	0	0	1	0
MLU in words	10.86	7.57-14.21	2.38	3.26	2.24	2.50
Verb phrases expanded	18.85	6-40	10	2	1	4
Total verb phrases	51.07	29-86	35	24	10	4
Syntactic complexity score	5.25	4.5-6.6	2.56	2.00	2.07	2.17
Clausal complexity	9.91	7.33-15.83	3.11	2.83	2.86	1.79
Phrase complexity	15.79	12.79-18.39	7.56	6.83	5.36	6.86
Syntactic Stages						
Stage I clause	0.14	0-1	3	4	1	2
Stage II clause	11.07	5-20	11	15	6	4
Stage III clause	23.42	13-36	21	5	5	5
Stage IV clause	15.35	3-30	1	1	0	0
Stage V clause	21.92	9-47	4	3	1	0
Stage VI clause	2.07	0-6	0	0	0	0
Stage VII clause	3.21	0-8	0	0	1	0
No. of connectives	23.85	13-44	13	7	2	2
Lexical						
Nouns – Types	47.07	31-75	13	31	9	6
Nouns – Tokens	66.85	38-126	17	31	9	6
Verbs – Types	35.85	23-62	15	8	5	7
Verbs – Tokens	51.21	28-90	21	11	5	8
Verb valency						
Intransitive types	17.28	6-36	7	2	4	4
Intransitive tokens	23.92	8-48	10	2	4	4
Transitive verb types	19.00	12-28	8	6	1	3
Transitive verb tokens	26.28	15-52	11	9	1	4
Ditransitive types	0.429	0-2	0	0	0	0
Ditransitive tokens	0.857	0-4	0	0	0	0
Inflection						
Present inflection -ing	8.64	2-20	2	0	0	0
Past inflection -ed	1.143	0-4	0	0	0	0
Irregular past	0.929	0-3	0	1	0	1

Table F.5 Mean and range values of spontaneous speech measures for normal speakers and from four samples of P5 obtained during baseline, after module1 (post-word), module 2 (post-affix) and module 3 (post-sentence).

Measures	Mean	Range	Baseline	Post-word	Post-affix	Post-sentence
Utterances						
Total utterances	31.78	19-54	42	42	87	49
Spontaneous utterances	26.42	11-52	37	30	78	42
Minor utterances	1.57	0-6	7	4	12	5
Major utterances	29.14	17-46	35	33	73	37
Unanalyzed utterances	0.00		0	0	0	0
Problematic utterances	0.07	0-1	0	1	1	0
MLU in words	10.86	7.57-14.21	6.24	6.71	5.31	5.69
Verb phrases expanded	18.85	6-40	14	27	40	17
Total verb phrases	51.07	29-86	42	51	80	56
Syntactic complexity score	5.25	4.5-6.6	3.37	3.87	3.00	3.53
Clausal complexity	9.91	7.33-15.83	10.21	9.58	5.29	6.49
Phrase complexity	15.79	12.79-18.39	11.09	12.61	12.04	12.66
Syntactic Stages						
Stage I clause	0.14	0-1	2	0	2	2
Stage II clause	11.07	5-20	8	9	22	10
Stage III clause	23.42	13-36	22	32	46	34
Stage IV clause	15.35	3-30	12	9	14	7
Stage V clause	21.92	9-47	25	17	18	16
Stage VI clause	2.07	0-6	1	3	0	1
Stage VII clause	3.21	0-8	12	9	8	4
No. of connectives	23.85	13-44	9	10	22	11
Lexical						
Nouns – Types	47.07	31-75	18	21	30	21
Nouns – Tokens	66.85	38-126	23	32	46	30
Verbs – Types	35.85	23-62	9	22	28	25
Verbs – Tokens	51.21	28-90	23	37	76	43
Verb valency						
Intransitive types	17.28	6-36	4	9	12	6
Intransitive tokens	23.92	8-48	9	14	18	12
Transitive verb types	19.00	12-28	5	13	14	17
Transitive verb tokens	26.28	15-52	14	23	49	17
Ditransitive types	0.429	0-2	0	0	2	2
Ditransitive tokens	0.857	0-4	0	0	5	4
Inflection						
Present inflection -ing	8.64	2-20	0	2	5	9
Past inflection -ed	1.143	0-4	0	0	0	0
Irregular past	0.929	0-3	2	2	3	5

Table F.6 Mean and range values of spontaneous speech measures for normal speakers and from four samples of P6 obtained during baseline, after module1 (post-word), module 2 (post-affix) and module 3 (post-sentence).

Measures	Mean	Range	Baseline	Post-word	Post-affix	Post-sentence
Utterances						
Total utterances	31.78	19-54	21	17	23	16
Spontaneous utterances	26.42	11-52	0	5	18	9
Minor utterances	1.57	0-6	1	7	1	4
Major utterances	29.14	17-46	12	4	22	8
Unanalyzed utterances	0.00		5	6	1	4
Problematic utterances	0.07	0-1	4	1	0	0
MLU in words	10.86	7.57-14.21	2.14	1.65	1.21	1.63
Verb phrases expanded	18.85	6-40	0	0	0	0
Total verb phrases	51.07	29-86	0	0	0	1
Syntactic complexity score	5.25	4.5-6.6	1.00	0.50	1.00	1.25
Clausal complexity	9.91	7.33-15.83	0.92	1.25	1.14	1.50
Phrase complexity	15.79	12.79-18.39	1.67	1.50	1.91	3.13
Syntactic Stages						
Stage I clause	0.14	0-1	7	2	22	8
Stage II clause	11.07	5-20	2	0	0	2
Stage III clause	23.42	13-36	0	1	1	0
Stage IV clause	15.35	3-30	0	0	0	0
Stage V clause	21.92	9-47	0	0	0	0
Stage VI clause	2.07	0-6	0	0	0	0
Stage VII clause	3.21	0-8	0	0	0	0
No. of connectives	23.85	13-44	0	0	0	0
Lexical						
Nouns – Types	47.07	31-75	4	2	10	8
Nouns – Tokens	66.85	38-126	9	4	23	9
Verbs – Types	35.85	23-62	0	0	0	1
Verbs – Tokens	51.21	28-90	0	0	0	1
Verb valency						
Intransitive types	17.28	6-36	0	0	0	0
Intransitive tokens	23.92	8-48	0	0	0	0
Transitive verb types	19.00	12-28	0	0	0	1
Transitive verb tokens	26.28	15-52	0	0	0	1
Ditransitive types	0.429	0-2	0	0	0	0
Ditransitive tokens	0.857	0-4	0	0	0	0
Inflection						
Present inflection -ing	8.64	2-20	0	0	0	0
Past inflection -ed	1.143	0-4	0	0	0	0
Irregular past	0.929	0-3	0	0	0	0

Table F.7 Mean and range values of spontaneous speech measures for normal speakers and from samples of P1 and P2 obtained during baseline (B) and after verb argument module1 (I).

Measures	Mean	Range	P1-B	P1-I	P2-B	P2-I
Utterances						
Total utterances	31.78	19-54	16	26	40	42
Spontaneous utterances	26.42	11-52	11	18	16	18
Minor utterances	1.57	0-6	4	4	1	4
Major utterances	29.14	17-46	8	14	16	17
Unanalyzed utterances	0.00		1	1	0	0
Problematic utterances	0.07	0-1	0	0	17	21
MLU in words	10.86	7.57-14.21	3.00	2.09	3.05	2.69
Verb phrases expanded	18.85	6-40	3	2	0	0
Total verb phrases	51.07	29-86	6	8	0	2
Syntactic complexity score	5.25	4.5-6.6	3	2	1.4	1.15
Clausal complexity	9.91	7.33-15.83	2.63	2.69	1.38	1.24
Phrase complexity	15.79	12.79-18.39	6.5	3.35	6.5	4.18
Syntactic stages						
Stage I clause	0.14	0-1	1	8	8	13
Stage II clause	11.07	5-20	4	7	2	0
Stage III clause	23.42	13-36	4	4	0	1
Stage IV clause	15.35	3-30	0	0	0	0
Stage V clause	21.92	9-47	0	1	2	1
Stage VI clause	2.07	0-6	0	0	0	0
Stage VII clause	3.21	0-8	0	0	0	0
No. of connectives	23.85	13-44	0	1	4	2
Lexical						
Nouns – Types	47.07	31-75	11	10	25	19
Nouns – Tokens	66.85	38-126	11	21	39	26
Verbs – Types	35.85	23-62	5	6	4	3
Verbs – Tokens	51.21	28-90	5	8	4	3
Verb valency						
Intransitive types	17.28	6-36	3	4	4	2
Intransitive tokens	23.92	8-48	3	5	4	2
Transitive verb types	19.00	12-28	2	2	0	1
Transitive verb tokens	26.28	15-52	2	3	0	1
Ditransitive types	0.429	0-2	0	0	0	0
Ditransitive tokens	0.857	0-4	0	0	0	0
Inflection						
Present inflection -ing	8.64	2-20	0	4	2	1
Past inflection -ed	1.143	0-4	0	0	0	0
Irregular past	0.929	0-3	2	1	0	0

Table F.8. Mean and range values of spontaneous speech measures for normal speakers and from samples of P7 and P8 obtained during baseline (B) and after verb argument module1 (I).

Measures	Mean	Range	P7-B	P7-I	P8-B	P8-I
Utterances						
Total utterances	31.78	19-54	28	36	43	43
Spontaneous utterances	26.42	11-52	19	31	43	38
Minor utterances	1.57	0-6	3	1	7	8
Major utterances	29.14	17-46	19	35	36	30
Unanalyzed utterances	0.00		0	0	0	0
Problematic utterances	0.07	0-1	0	1	0	2
MLU in words	10.86	7.57-14.21	8.32	10	9.1	7.07
Verb phrases expanded	18.85	6-40	16	19	25	11
Total verb phrases	51.07	29-86	35	53	56	33
Syntactic complexity score	5.25	4.5-6.6	4.48	4.54	4.93	3.86
Clausal complexity	9.91	7.33-15.83	7.6	8.69	8.67	4.89
Phrase complexity	15.79	12.79-18.39	11.36	15	15.95	12.71
Syntactic stages						
Stage I clause	0.14	0-1	1	0	0	0
Stage II clause	11.07	5-20	11	14	9	5
Stage III clause	23.42	13-36	13	24	35	20
Stage IV clause	15.35	3-30	12	14	14	10
Stage V clause	21.92	9-47	12	22	23	8
Stage VI clause	2.07	0-6	1	4	5	0
Stage VII clause	3.21	0-8	2	2	2	3
No. of connectives	23.85	13-44	10	26	40	23
Lexical						
Nouns – Types	47.07	31-75	27	31	23	25
Nouns – Tokens	66.85	38-126	50	51	58	59
Verbs – Types	35.85	23-62	22	40	16	12
Verbs – Tokens	51.21	28-90	31	57	45	20
Verb valency						
Intransitive types	17.28	6-36	12	23	5	5
Intransitive tokens	23.92	8-48	16	28	11	9
Transitive verb types	19.00	12-28	10	15	10	6
Transitive verb tokens	26.28	15-52	15	24	31	10
Ditransitive types	0.429	0-2	0	1	1	1
Ditransitive tokens	0.857	0-4	0	3	3	1
Inflection						
Present inflection -ing	8.64	2-20	2	8	5	2
Past inflection -ed	1.143	0-4	1	2	1	1
Irregular past	0.929	0-3	0	2	6	10

G Appendix G

This appendix contains the following:

a) Raw scores for the control probe for participants P1, P2 and P5 (see Section G.1).

b) Result graphs for participants P3, P4 and P6 in response to the experimental intervention (see Section G.2).

G.1 Control probe

Table G.1 Raw scores for the control probe for participants P1, P2 and P5

	Baseline	Post-word	Post-affix	Post-sentence
P1	4	6	3	4
P2	2	2	1	1
P5	2	2	2	2

G.2 Participants P3, P4 and P6

Three of the six participants in Study 1 showed a poor response to the experimental intervention. Therefore, the results for the experimental intervention were not presented in chapter 6. The graphs for these three participants are presented in this Appendix. The graphs represent the production of the target word or sentence in response to the experimental intervention. The participants' responses to the verb modules and the noun modules of intervention are included.

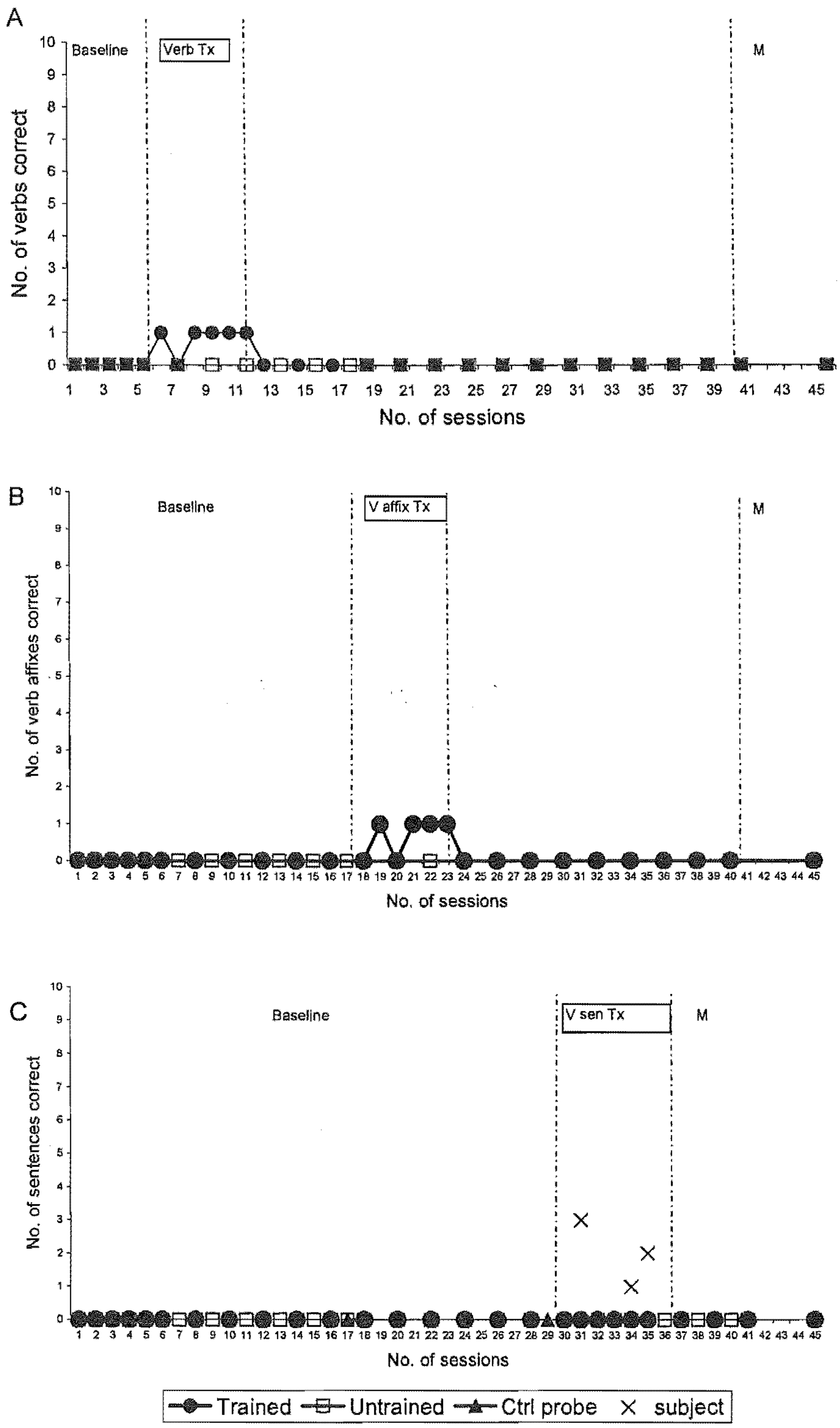


Figure G.1. P3: Session-by-session data record for different verb forms. The above figure shows the production of verbs in isolation (A, session 6-11), verb affixes (B, session 18-23) and verb sentences (C, session 30-35) associated with the introduction of experimental intervention. The clause element subject was produced instead of sentences and is plotted in panel C.

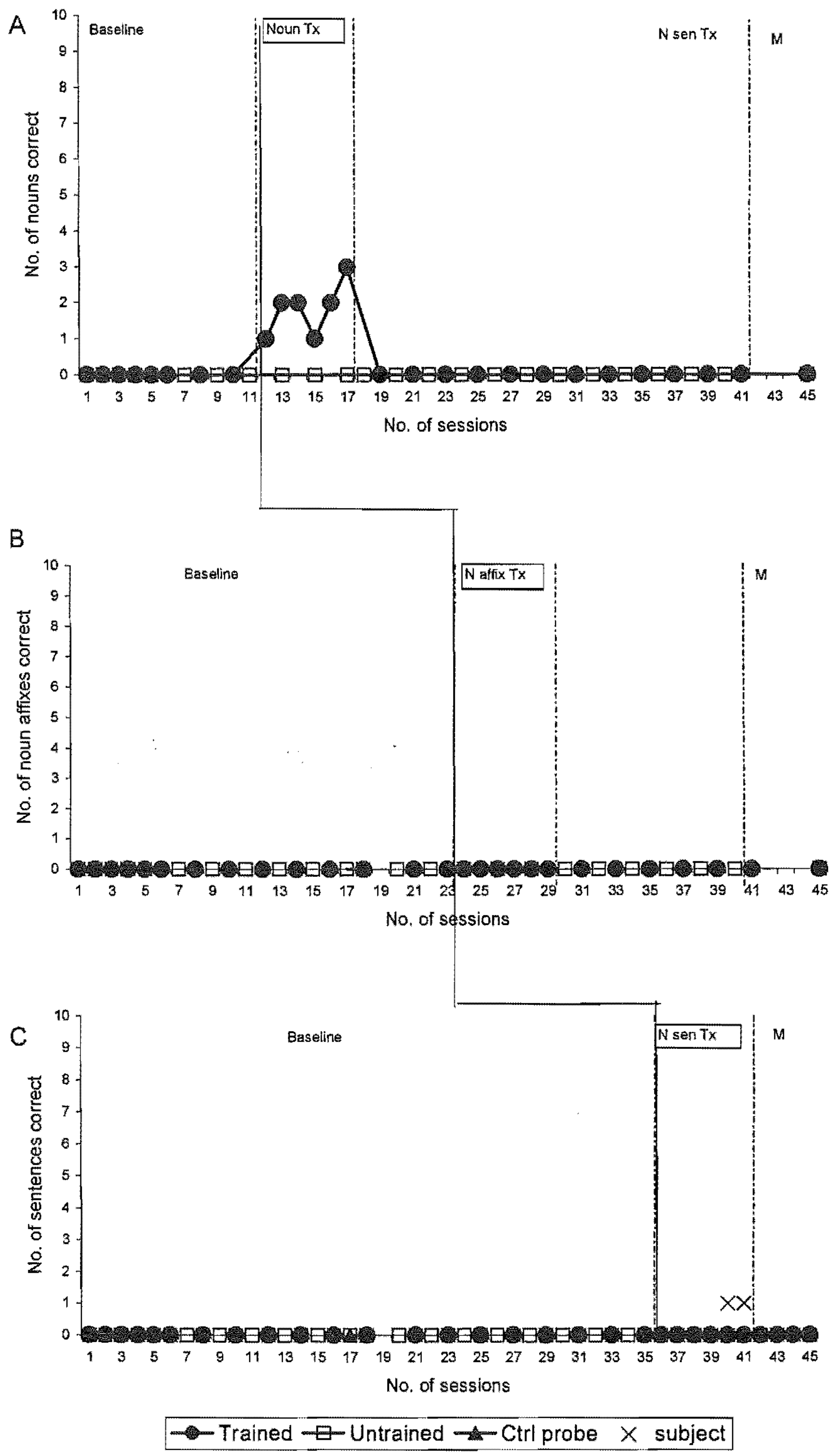


Figure G.2. P3: Session-by-session data record for different noun-forms. The above figure shows the production of nouns in isolation (A, session 12-17), noun affixes (B, session 24-29) and noun sentences (C, session 36-41) associated with the introduction of experimental intervention. 'x' refers to the production of the clause element 'subject' instead of the target sentence.

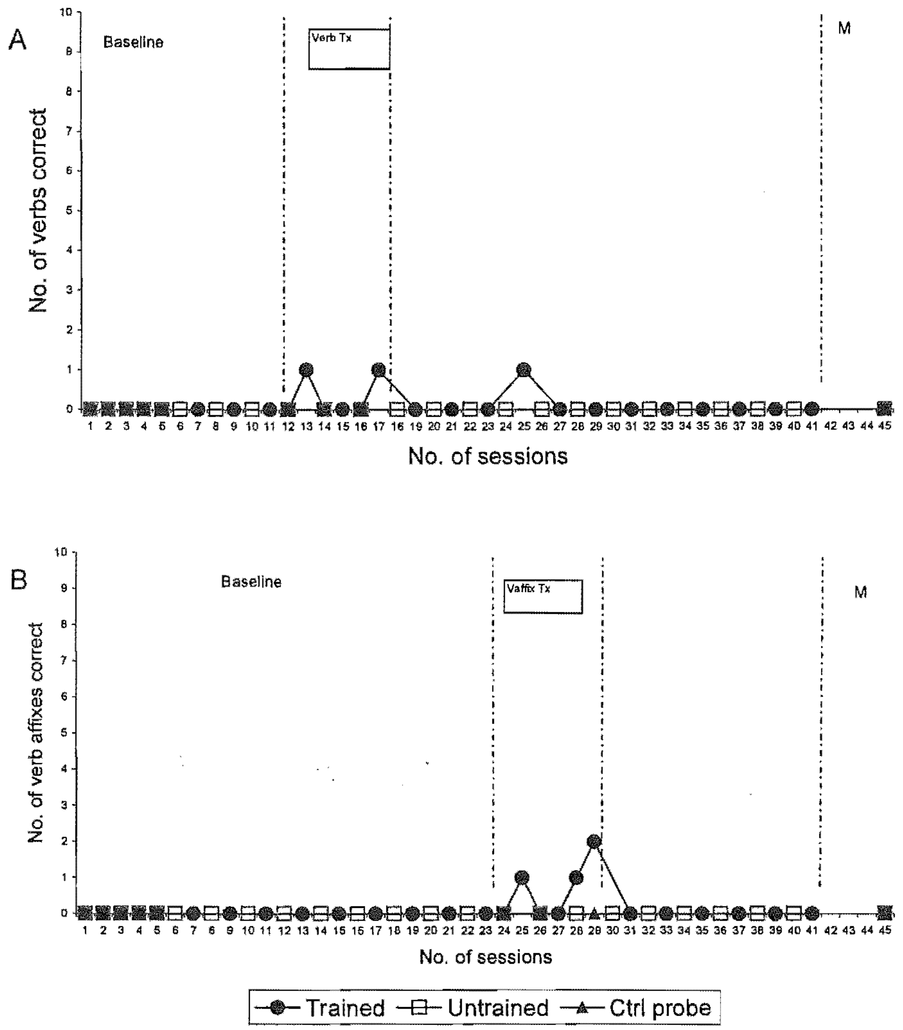


Figure G.3. P4: Session-by-session data record for different verb-forms. The above figure shows the production of verbs in isolation (A, session 12-17), verb affixes (B, session 24-29) associated with the introduction of experimental intervention. P4 did not produce any sentences, hence no graph for sentence module.

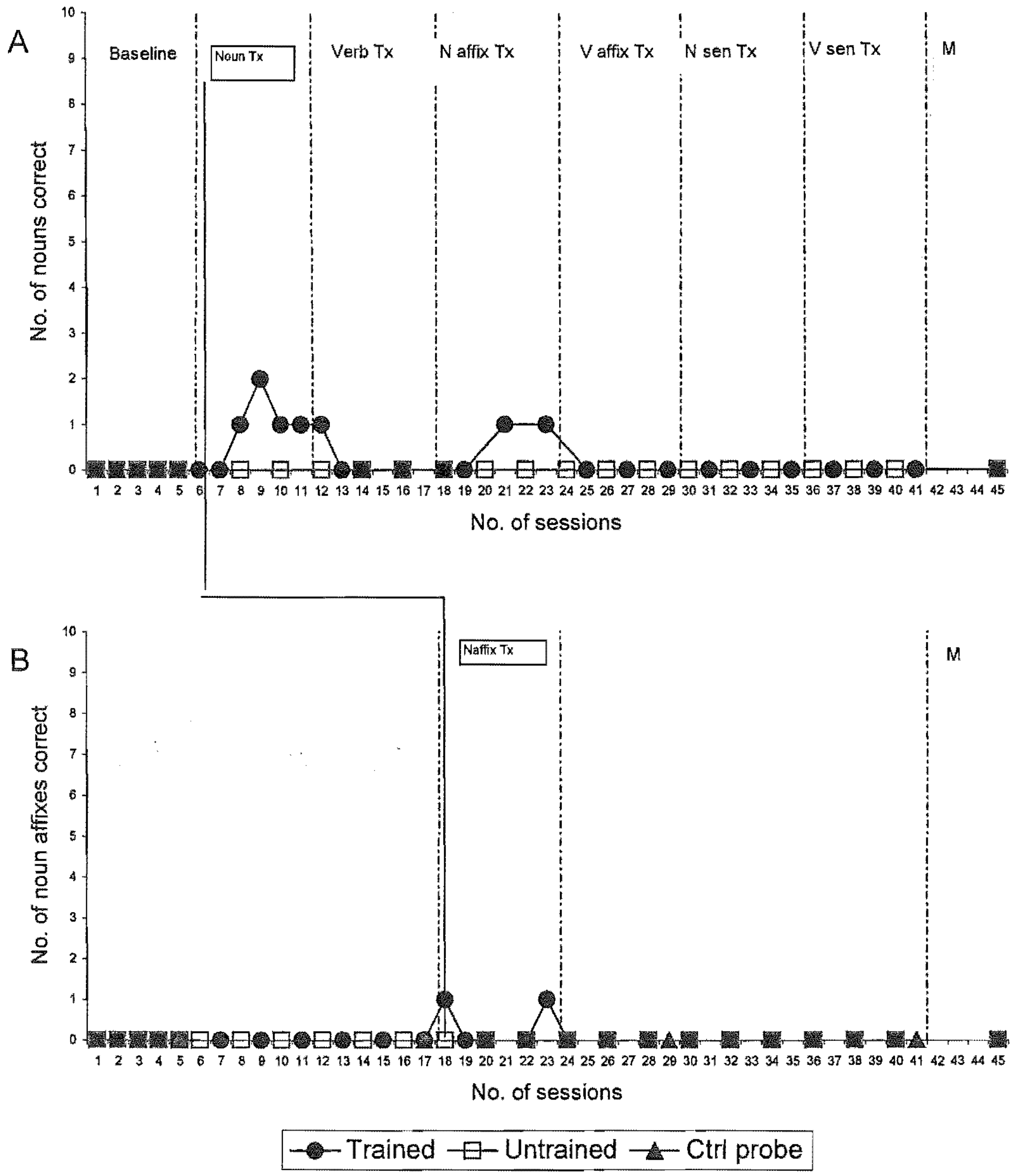


Figure G.4. P4: Session-by-session data record for different noun-forms. The above figure shows the production of nouns in isolation (A, session 6-11), noun affixes (B, session 18-23) associated with the introduction of experimental intervention. P4 did not produce any sentences in the sentence module, hence no graph for sentence module.

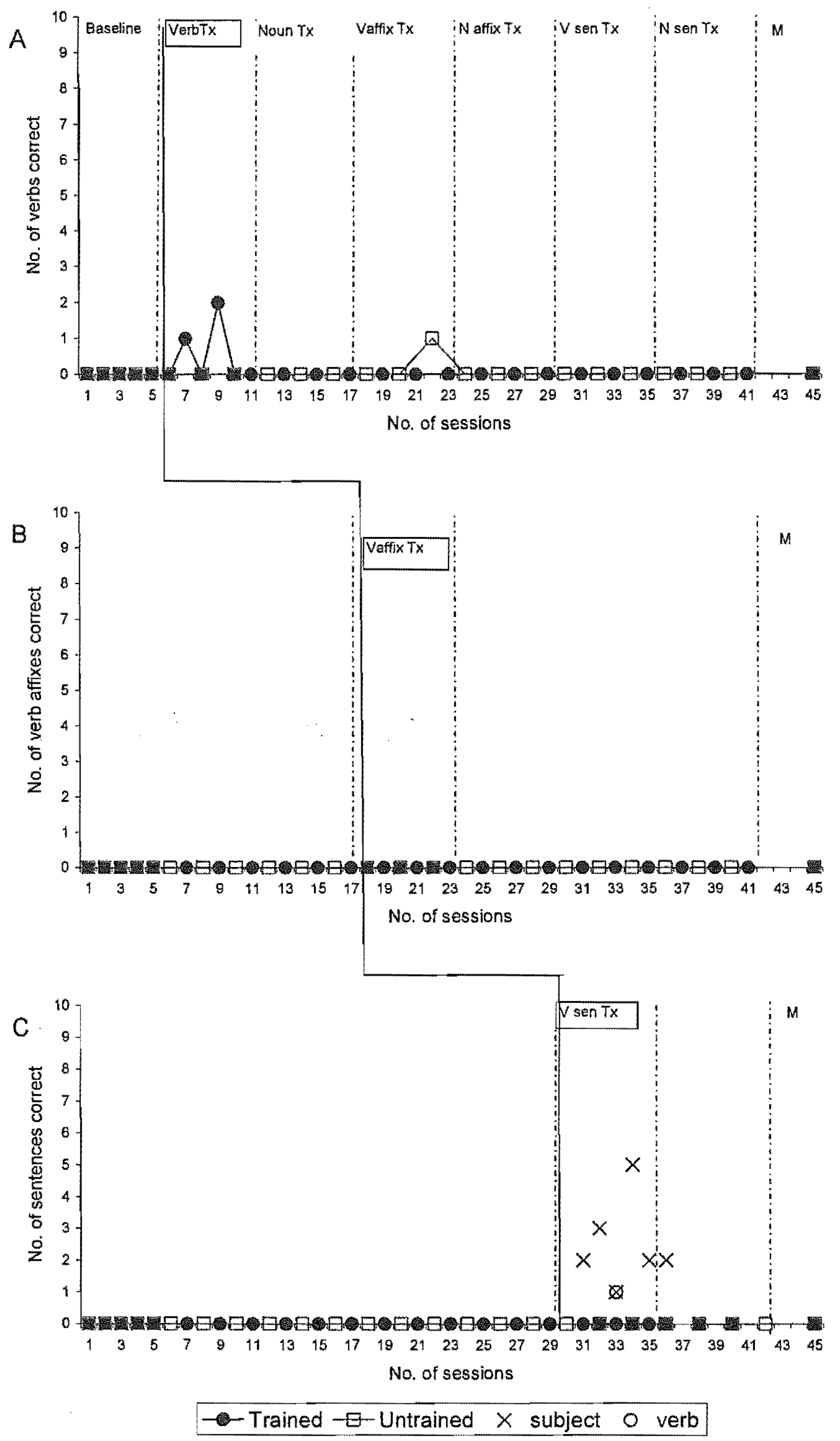


Figure G.5. P6: Session-by-session data record for different verb-forms. The above figure shows the production of verbs in isolation (A, session 6-11), verb affixes (B, session 18-23) and verb sentences (C, session 30-35) associated with the introduction of experimental intervention. The different clause elements produced instead of sentences are represented as subject and verb in panel C.

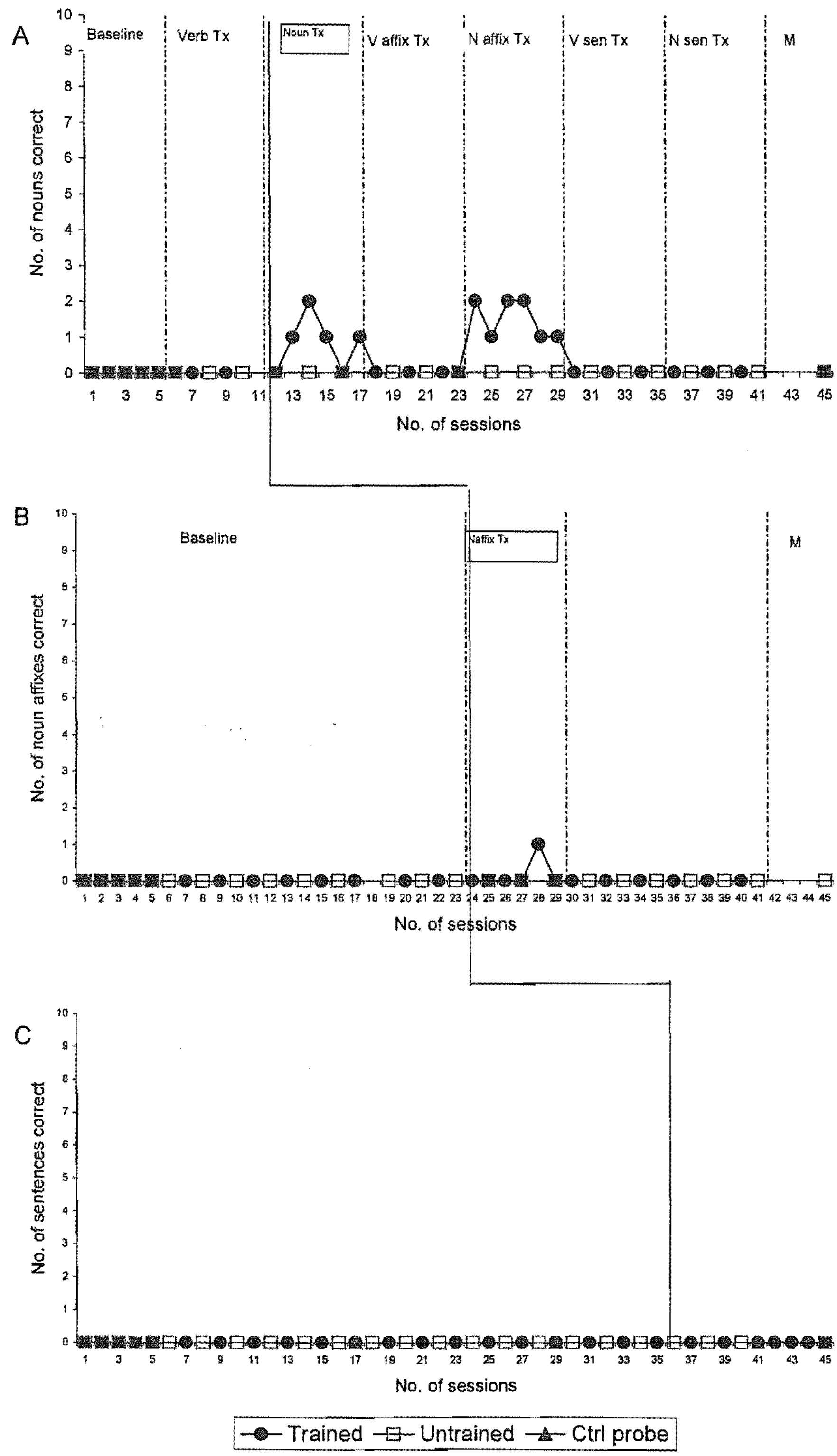


Figure G.6. P6: Session-by-session data record for different noun-forms. The above figure shows the production of nouns in isolation (A, session 12-17), noun affixes (B, session 24-29) and noun sentences (C, session 36-41) associated with the introduction of experimental intervention.

Appendix H

This appendix consists of anecdotal evidence for the improvement seen in P3 in Study 1 as noticed by another resident of the same rest home A.N. (personal information). Information about the author of the poem suppressed.

TRIUMPHS

In disguise

No These are not the shared proud moments
With leather balls at stadia,

Nor climbing a formidable mountain
With steel legs and crampons
And pain and huge determination,

Nor wide-eyed little ones
Facing unknown treatment
With child-like trust

Yes These are triumphs in disguise
Firstly, the word 'Hello' aloud
Spoken by a smiling man
From his wheelchair
After four whole years' silence
And a raised hand for a greeting.

Secondly, six slow steps –
Laborious, will-powered.
Illness, like a Home Invasion,
Had robbed him of almost everything
And a full-scale smile came too,
Rivalling a scored goal at a test match.

Please acknowledge these triumphs.
They are awesome too.

GLOSSARY

Explanation of terms as used in this thesis

Term	**Explanation**
Agent	The thematic role of an agent is assigned to the person who does the action. For example, *she* in *She cracked the egg.*
Argument structure	The set of elements that represent the grammatical information about the verb. For example, the verb *give* has three arguments; agent (*girl*), theme (*bone*) and recipient (*dog*) in *The girl gives a bone to the dog.*
Canonical sentences	Sentences that follow the standard word order i.e., subject-verb-object. For example, *The boy hit the cat.*
Cognitive neuropsychological (CNP) approach	The CNP approach examines the cognitive abilities of brain damaged individuals using theories of normal language processing in order to develop a theory about the nature of the cognitive processes used to perform a particular task.
External argument	In a sentence, arguments of a verb can be in the verb phrase of the sentence or outside the verb phrase. The argument that is outside the verb phrase is called an external argument e.g., *Tom* in *Tom likes books.*
Grammar of Contemporary English (GCE)	GCE is a corpus-based reference grammar and is an example of a non-generative grammar.
Grammatical constituents	Refers to the different parts of a clause in a sentence such as subject, verb and object.
Grammatical Encoding Model (GEM)	GEM is a combination of selected concepts from models of sentence production by Garrett (1984), Lapointe and Dell (1989), Bock and Levelt (1994) and Levelt (1999).

Information processing model	A model that explains the steps used to perform a particular task in the form of modules or sub-processors. The flow of information is from one module to another.
Internal argument	The argument of a verb that is realized inside the verb phrase is an internal argument e.g., *book* and *shelf* in *She put a book on the shelf.*
Lemma	A lemma is a non-phonological entity that specifies the meaning and syntax of a lexical concept. A lemma does not specify the word form (Kempen and Hjuibers, 1983)
Lexeme	The phonological form of a lexical concept is known as a lexeme.
Lexical hypothesis	Sentence production is dependent upon the information present in the verb representation and therefore verb retrieval impairment will affect sentence production (Marshall, 1998).
Light verbs	Verbs that have a relatively non-specific meaning and function as tense carriers rather than the main verb e.g., *get, come, make* (Pinker, 1989).
Mapping deficit	An inability to relate *who did what to whom* i.e., an inability to correlate the grammatical roles with the functional roles is known as the mapping deficit.
Noun sentence	Noun sentences refer to sentences with the grammatical structure subject-verb-complement (SVC) (e.g., *the man's arm is hurt*)
One-place verb	Verbs that take only an external argument such as an agent e.g., *the boy smiles.*
Proposition	A proposition is an utterance that is a sequence of words such that the relationship among the words reflects a new meaning that is different from the meaning of the individual words.

Recipient	A recipient is an animate entity who receives the theme in some action e.g., *boy* in *the woman threw a ball to the boy*
Thematic roles	The abstract roles (e.g., *agent, recipient* etc.) that the arguments of a verb fulfill in a conceptual structure are known as thematic roles.
Theme	The entity that changes state as an effect of what the agent does is called the theme. For example, in the sentence *the ball is in the garden, the ball* fulfills the role of theme.
Three-place verb	A verb that requires three arguments such as agent, theme and goal e.g., *the girl gives a bone to the dog.*
Transformational grammar	According to Transformational grammar, an individual can create an infinite number of grammatical utterances and this ability can be explained by a finite set of rules (Chomsky, 1957). Two levels of sentence structure are proposed: a deep structure and a surface structure.
Two-place verb	A verb that requires two arguments such as agent and theme e.g., *the boy catches the ball.*
Verb sentence	Verb sentences refer to the sentences with the grammatical structure subject-verb-object (SVO) (e.g., *the woman wiped the board*) and subject-verb-object-object (SVOO) (e.g., *the woman asked the man a question*).